PUBLICATION 296

1989-1990
Field Crop Recommendations

Ontario

Ministry of
Agriculture
and Food

Jack Riddell, Minister

SOILS

CEREALS

PESTICIDES

90-06153/

To the best of the collective knowledge of the members of the Ontario Crop Protection Committee, all pesticides listed in this publication were federally registered, reviewed by the Ontario Pesticides Advisory Committee and classified by the Ministry of the Environment as of November 9, 1988.

The information presented on the pesticide container label regarding application rates and methods of application are the final authority and where conflicts occur between this publication and the container label, the latter applies.

PAY CLOSE ATTENTION TO ALL INSTRUCTIONS AND WARNINGS PRINTED ON THE PESTICIDE LABEL.

The Ministry of Agriculture and Food, or the Ontario Crop Protection Committee by printing this publication does not offer any warranty or guarantee and they do not assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

POLICY STATEMENT

In this publication, most recommendations list several pesticides that are effective for each insect or disease discussed. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first. These are followed by the more toxic pesticides and/or newer ones with which we have less experience. It must be emphasized that, in some cases, the most effective pesticides are highly toxic.

Weather and other factors influence the effectiveness of pesticides and the likelihood of plant injury by control chemicals. Consult the package label and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, etc. Wettable or soluble powders (WP or SP) generally are less likely to cause plant injury than liquid concentrates (EC, SC, and F).

A number of brand names of pesticides are given in the calendars as a convenience to the grower and are neither an endorsement of the product nor a suggestion that similar products are not effective.

The pesticide recommendations are reviewed annually by the Ontario Crop Protection Committee. **OLD EDITIONS SHOULD BE DISCARDED.**

For additional information or clarification of recommendations, contact Ontario Ministry of Agriculture and Food personnel listed on page 00.

FEDERAL REGISTRATION AND PROVINCIAL CLASSIFICATION

Ontario's Pesticides Act and Regulations 751, administered by the Ministry of the Environment, prohibits the sale and use of pesticide products unless they are registered under the federal Pest Control Products Act and classified under the provincial Pesticides Act by being placed in one of six schedules of the Ontario regulation.

FEDERAL REGISTRATION

There are three categories:

1. **Full Registration**

   Implies that all federal departments involved in the registration process agree that the package was acceptable at the time of registration.

2. **Temporary Registration**

   Indicates that there is a need for additional scientific or technical information to acquire a full registration. Temporary registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use in the following year.

3. **Temporary Registration (Restricted Class)**

   Indicates that there is an urgent need for the pesticide but that studies on the safety of the product are incomplete. Such registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use the following year. The pesticide product presently carrying temporary registration (restricted class) and included in this publication is Bayleton (triadimefon). This material may, or may not, be available for use in 1989.

PROVINCIAL CLASSIFICATION

Pesticide products are classified into six schedules in Regulation 751 on the basis of their toxicity, environmental or health hazard, persistence of the active ingredient or its metabolites, concentration and usage. This classification system provides the basis for regulating the distribution, availability and use of pesticide products in Ontario.

For updated information on the regulatory status of these or other pesticides contact the Pesticides Section, Hazardous Contaminants Coordination Branch, Ministry of the Environment, Toronto, Telephone 416-323-5095.

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This issue of Publication 296 contains crop production information for both 1989 and 1990. Be sure to keep it for these two years. For 1990, a supplement updating variety and pesticide recommendations will be issued.

SOIL MANAGEMENT AND FERTILIZER USE

Ontario currently uses about 1,000,000 tonnes of fertilizers annually. High yields can be produced efficiently only when fertilizer use is related to the fertility level of the soil and to other additions of nutrients in manure, crop residues, etc. At one extreme, on very low fertility soils, it is occasionally profitable to add as much or more nitrogen, phosphorus, or potassium in the fertilizer as a crop removes. At the other extreme, on high fertility soils or following heavy application of manures, fertilizer may not be profitable and occasionally may reduce yields.

SOIL TESTING

Why Soil Test?

Soil testing is currently by far the most accurate tool available to Ontario farmers to determine the amounts of phosphorus, potassium and magnesium fertilizers and lime which should be applied to field crops.

Other Methods of Assessing Nutrient Needs

1. Plant analysis is the main tool used for tree fruits and can serve as additional information supporting the soil test for field and vegetable crops.
2. Nutrient deficiency symptoms on crop leaves are helpful in some cases but have serious drawbacks in others, particularly with potassium and phosphorus.
3. It is occasionally suggested that a farmer apply the amounts of nutrients removed by the crop. This has some application for nitrogen, as with some crops the suggested rate approximates what the plant removes. It has little relevance for other nutrients in Ontario. Many of our clay and clay loam soils have sufficient potassium to last many years and application of potassium each year on those soils is a waste of money and ignores one of the few advantages which clay soils have over coarser-textured soils.

The soil testing program is the main guide along with help from plant analysis and nutrient deficiency symptoms to determine your fertilizer requirements for a specific crop on a specific field.

What does the OMAF Soil Testing Program Provide for the Farmer?

The soil testing program provides recommendations for nitrogen, phosphate, potash and magnesium fertilizer along with recommendations for the amount and type of lime you should apply. These recommendations are expected to produce maximum profits under recommended management methods. Some fertilizer is recommended at soil test levels slightly above those where crop response is profitable. This is done to maintain high soil nutrient levels, and to allow for some error in sampling the field. For high value crops such as tobacco, the maximum profit we aim for will require essentially the same amount of fertilizer as maximum crop value (maximum yield with high quality). For low value crops such as oats there may on occasion be a slight yield response to rates of fertilizer above those recommended for maximum profit. However, trials on farm fields with corn have shown no yield response to rates of fertilizer above those recommended by soil test. Further assistance in interpreting soil test reports is available from the County and District agricultural offices of the Ontario Ministry of Agriculture and Food.

Soil Tests from Other Laboratories

Each year a number of farmers ask OMAF staff to interpret soil test results from other laboratories. Provided the other laboratory uses the identical tests used for the OMAF service and expresses their test results in the same units, the OMAF fertilizer requirements for phosphate and potash can be applied.

Only soil tests using chemical extractants which have been calibrated by a number of field experiments on Ontario soils can be relied on to provide accurate fertilizer recommendations. Be certain that the service you are using measures up to these standards.

A number of laboratories provide tests such as exchange capacity, aluminum and copper not provided through the OMAF services. These are not provided by the OMAF service because they have not been found to contribute to better fertilizer recommendations. Research has shown that on Ontario soils use of exchange capacity to adjust potash recommendations can lead to less reliable recommendations than are now provided.

Soil Sampling

Soils may be sampled with a sampling tube or with a shovel. Each field, or uniform section of a field should be sampled separately. At least 20 soil cores 15 cm deep should be taken from any field or area sampled up to 5 ha in size. For fields larger than 5 ha, proportionately more cores should be taken. The more cores taken the more likely the soil sample is to provide a reliable measure of the fertility in the field. One sample should not represent more than 10 hectares.

The soil can be collected in a clean pail, the lumps should be broken, the soil mixed well and a soil sample box forwarded for testing. The area sampled should be traversed in a zigzag pattern to provide a uniform distribution of sampling sites. Parts of a field that differ in appearance of soil or crop, in previous fertilization, manuring or liming should be sampled separately, even if they are too small to fertilize separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or where lime, manure, compost or crop residues have been piled.

When to Sample

Each field should be sampled once every two or three years. Potash levels can change quickly where large amounts of nutrients are removed from sandy soils (for example with crops such as alfalfa hay, corn silage, potatoes or tomatoes) and manure is not returned. Under these conditions samples should be taken each year.

The results of soil tests are forwarded to the grower within five days of receipt of samples in the laboratory. However, to allow time for mailing and analysis, soil samples from fields to be fertilized for spring seeding crops should be taken the previous fall. Because of the rush of harvest and the frequency of poor weather late in the fall, summer may be a more convenient time to sample for some farmers. Soil samples from fields to be fertilized for fall wheat, or from hay and pasture fields to be fertilized in late summer, should be taken in the spring or early summer.

Sample Boxes and Information Sheets

Soil sample boxes and information sheets, and information on the cost of various tests may be obtained from any local office of the Ministry of Agriculture and Food.

Management practices which affect a soil test recommendation are: manure application, legume sod plowed down, and the crop to be fertilized. This information is essential for a reliable fertilizer recommendation, and should be recorded on the field information sheet which must accompany the soil sample sent in for analysis.

Micronutrient Tests

Manganese and zinc tests are provided by the OMAF service. In the case of zinc on corn the soil test is best used in conjunction with visual deficiency symptoms. With manganese, plant analysis, visual symptoms and the soil test are all useful. The OMAF service does not provide a soil test for boron, copper, iron, or molybdenum.

Contamination Great care is required to prevent contamination of soil samples with micronutrients, particularly zinc. Do not use galvanized (zinc plated) soil sampling tubes to take soil samples for micronutrient tests. Do not use metal containers to collect and mix samples. Clean plastic containers in good condition should be satisfactory. Soil samples which have contacted galvanized surfaces are unsatisfactory for zinc soil tests. Be careful to keep dust around buildings etc. out of the samples.

Soil Sampling Micronutrient deficiencies frequently occur in small patches in fields. In these cases soil or plant analysis taken from the entire field are unlikely to find the problem. Sample problem areas separately.

Preventing and Correcting Manganese Deficiency Manganese is less available at high soil pH so it is important not to add more lime than is needed to correct soil acidity. For materials and rates to correct a deficiency, consult the cereals or soybeans sections under *Micronutrients.*

Table 1. Manganese Soil Test Interpretation

Manganese Soil Test	Suggested Treatments
greater than 30	Soil manganese availability is adequate for field grown crops.
16 to 30	Soil manganese availability is adequate for many crops but is approaching deficiency levels for oats, barley, wheat and soybeans. If deficiency symptoms appear, spray with manganese. Consider a re-check for deficiency using plant analysis.
below 16	Soil manganese availability is believed to be insufficient for oats, barley, wheat and soybeans. Spray with manganese at the four-leaf stage and again three weeks later if required. Manganese deficiency has not been diagnosed on corn in Ontario, even on soils which are very deficient for wheat.

Preventing and Correcting Zinc Deficiency High phosphorus in the soil and/or in the fertilizer can cause or increase the severity of zinc deficiency. **Apply only the recommended amount of phosphorus.** Use of animal manures can prevent or reduce zinc deficiency. Erosion control can prevent deficiency of zinc by maintaining the topsoil.

Zinc deficiency can be prevented by application of zinc fertilizer to the soil. Foliar sprays can be useful to correct a deficiency after the symptoms have appeared provided this is done early in the growing season. For materials and rates to correct a deficiency, consult the corn section under *Micronutrients.*

Table 2. Zinc Soil Test Interpretation

Zinc Soil Test	Suggested Treatments
greater than 200	You should suspect contamination of the sample or of the field.
25 to 200	Soil zinc availability is adequate for most field grown crops.
15 to 25	Zinc availability is adequate for most field crops except corn. Zinc availability is bordering on deficiency for corn. If the field sampled is uneven in soil texture, pH, or erosion, some areas may respond to zinc applications. Deficiency symptoms at the 4 to 6 leaf stage are a reliable indication of zinc deficiency (see OMAF Factsheet 100/531).
less than 15	Zinc is likely to be deficient for corn and should be applied in the fertilizer.

Copper soil tests are quite unreliable on Ontario soils but plant analysis is useful. Copper is unlikely to be deficient on mineral soil except perhaps on very sandy soils. Copper deficiency does occur on organic soils and is best diagnosed by plant analysis. When organic soils are first brought into cultivation, copper should be applied to the soil at 14 kg copper/ha for each of the first three years.

Boron is required on some soils for alfalfa. Boron deficiency usually occurs in dry weather so that response is erratic. Thus it has not been possible to develop a reliable soil test. Plant analysis is useful as a predicter of boron requirements as are visual symptoms on the plants. For rates of boron to correct a deficiency, consult the forages section under *Micronutrients.*

Boron deficiency has not been diagnosed on cereals, peas and beans in Ontario and boron applications to these crops, or applied to other crops in the year preceding them, can be toxic. **Boron should not be banded at seeding.**

Iron and **Molybdenum** have not been found to be deficient in field crops in Ontario.

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre.

Table 3. Analyses Available through the OMAF Soil Testing Service*

Materials	What is Analysed
1. Field Soils	Plant-available Phosphorus, Potassium and Magnesium; pH, Lime requirement
2. Home Garden and Lawn Soils	Plant-available Phosphorus, Potassium, Magnesium; pH; Lime requirement
3. Commercial Turf Soil	Plant-available Phosphorus, Potassium, Magnesium; pH; Lime requirement
4. Greenhouse Media	Plant-available Nitrogen, Phosphorus, Potassium, Calcium, Magnesium; pH; Total Salts
5. Nutrient Solutions, Water	Plant-available Nitrogen, Phosphorus, Potassium, Calcium, Magnesium; pH; Total Salts; Sulphates; Chlorides
6. All Soils (optional, on request only)	Plant-available Manganese and Zinc
7. All Soils (optional, on request only)	Organic Matter

**Consult your local office of the Ministry of Agriculture and Food for costs of the various tests.*

FERTILIZER RECOMMENDATIONS

Changes in Crop or Management

Fertilizer requirements on the OMAF soil test report are for specific crop and management. If the crop management is changed in regard to legumes plowed down or manure applied, the adjustments in fertilizer requirements may be made using the manure and legume sod adjustments in Tables 4 and 5. If the crop is changed from that for which the recommendation was made, a new recommendation can be obtained by looking up the appropriate table under the specific crop section in this publication.

Nitrogen

No soil test is available which is satisfactory for nitrogen under Ontario conditions. Nitrogen fertilizer recommendations for field crops are, therefore, based on estimated crop requirements and in some cases the region of the province. Rates are adjusted downward if manure is applied, or if the previous crop contains perennial legumes such as alfalfa.

Adjustment for Legumes Plowed Down

When sod containing perennial legumes such as alfalfa, trefoil and clover are plowed under, they supply an appreciable amount of nitrogen to the following crop. The accompanying table shows reductions which should be made in nitrogen fertilizer applications to crops following sod containing legumes.

Table 4. Adjustment of Nitrogen Requirement Where Crops Containing Legumes are Plowed Down

Type of Crop	For all Crops Deduct from N Requirement kg N/ha
Less than 1/3 legume	0
1/3 to 1/2 legume	55
1/2 or more legume	110
Perennial legumes seeded and plowed in the same year.	45[1]
Soybean and field bean residue	0

[1] *Applies where the legume stand is thick and over 40 cm high.*

Phosphate and Potash

Phosphate and potash recommendations are based on soil tests conducted by the Ontario Ministry of Agriculture and Food soil testing service. The requirements of these nutrients are presented in this publication in tables found in the Fertilizer Section for each crop. These tables should not be used with soil test readings from other soil testing laboratories unless the methods used are identical to those used by OMAF.

Where a soil test is not available, a rough estimate of requirements can be obtained from these tables using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the MEDIUM soil test rating.

b. If the field has received little fertilizer in the past, use one of the rates recommended for a LOW soil test rating.

Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizers. Only a soil test can adequately determine potash requirements.

PLANT ANALYSIS

Plant analysis measures the nutrient content of plant tissue. Comparing the results against the "normal" and "critical" values for the crop can indicate whether nutrient supply is adequate for optimum growth.

Plant analysis is a useful supplement to soil testing for evaluation of the fertility status of crops. It is quite independent of soil testing and can provide a valuable "second opinion", especially for phosphorus, potassium, magnesium and manganese. For nitrogen and zinc it has not been very reliable. For boron and copper we don't have a reliable soil test so plant analysis and visual symptoms are the only methods for diagnosing deficiencies.

Plant analysis has limitations. Expert help in interpreting the results is often needed since plant analysis does not always indicate the cause of a deficiency or the amount of fertilizer required to correct it.

Sampling

Time of sampling has a major effect on the results since nutrient levels within a plant vary considerably with the age of the plant. Results are difficult to interpret if samples are taken at times other than those recommended. Nevertheless, plants suspected of being nutrient deficient should be sampled as soon as a problem appears. Samples are best taken from a problem area rather than from the entire field.

Samples for plant analysis should be taken from at least 20 plants distributed throughout the area chosen for sampling. Each sample should consist of at least 100 grams of fresh material. Problem areas should be sampled separately. When taking samples for plant analysis take care not to contaminate the sample with soil. Even a small amount of soil will cause the results to be invalid, especially for micronutrients.

Sample Preparation

Samples of fresh plant material should be delivered directly to the laboratory. If they are not delivered immediately they should be dried to prevent spoilage. Samples may be dried in an oven at 65°C or less or dried in the sun provided precautions are taken to prevent contamination with dust or soil. Avoid contact of samples with galvanized (zinc coated) metal, brass or copper.

Plant analyses may be obtained from several laboratories in Ontario.

MANURE

Manure can supply organic matter and an appreciable part of the nutrients required for production of crops. Excessive rates of manure should be avoided because of the potential to cause water pollution problems.

Manure Storage

For maximum conservation of plant nutrients manure should be stored in a way that saves the liquid portion and allows as little exposure to the air as practicable.

Where to Use Manure

Manure is used most effectively when applied for crops that require nitrogen and on soils that require phosphorus and potassium. Manure should not be supplied at rates supplying more nitrogen than the crop requires. Corn and grass hay or pastures have higher nitrogen requirements than many other crops and therefore respond more to nitrogen in manure. Legumes such as alfalfa, trefoil and soybeans do not make efficient use of the nitrogen in the manure.

Manure on Perennial Legumes

Do not apply manure to perennial legumes such as alfalfa and trefoil when there is snow cover because ice frequently forms under the manure and can kill the plants. If manure must be applied to perennial legumes it should be applied to the thinnest or oldest stands, preferably after the first cutting.

Manure on Cereals

Manure or other sources of nitrogen applied to cereals at rates supplying more nitrogen than the crop requires can cause lodging and should be avoided.

Manure on Grass Sod

Manure is an effective source of nutrients for grass sod. However, where manure is to be applied in late spring or summer some nitrogen fertilizer should be applied early in the spring.

Manure on Leaves

Avoid application of liquid manure to crop foliage as it can

Table 5. Reductions in Fertilizer Application where Manure is Applied in the Same Crop Year[1]

Class of Livestock	Nitrogen (kg / ha)			Phosphate	Potash
	F.&W.[2]	Spr.[2]	Spr.C[2]	P_2O_2(kg / ha)	K_2O(kg / ha)
Liquid Manure at 10 cubic metre / hectare (900 gal. / acre)					
Cattle, Mixed Livestock	5	10	12	4	16
Swine	8	15	19	7	14
Poultry	23	46	58	22	26
Solid Manure at 10 tonnes / hectare (4.5 tons / acre)[3]					
Cattle, Mixed Livestock	12	24	30	10	44
Swine	15	30	38	20	26
Poultry	70	140	175	75	96

[1] *These adjustments are based on slightly below average quality manure.*

[2] *F.&W. denotes fall and winter applied manure; Spr. denotes spring applied and not covered immediately, including surface application after seeding; Spr. C. denotes spring applied manure injected or otherwise covered within one day of application.*

[3] *The density of manure in the spreader will vary from 400 kg/m^3 (25 lb/ft^3) for heavily bedded or very dry manure to 1000 kg/m^3 (62 lb/ft^3) for semi-solid or liquid manures.*

damage the crop. On perennial forages application to the foliage cannot be avoided but applications early in the spring or immediately after haying are preferred.

Short-Term Value of Manure

Table 5 shows the quantities of nutrients in manure applied in the year that the crop is grown. These values assume, for manure applied in the spring and not immediately covered with soil, that 50% of the nitrogen (75% for poultry manure), 40% of the phosphate and 90% of the potash are as available in the year of application as the nutrients in manufactured fertilizer. Thus the application of fertilizer nitrogen, phosphate and potash should be reduced accordingly.

Long-Term Value of Manure

The long-term availability of phosphorus, potassium or magnesium from manure applications in previous years is best measured by a soil test. Some of the nitrogen in manures also continues to become available in the years following application but in successively smaller quantities. Generally, 50 percent of the total manure nitrogen (75% for poultry manure) applied in the spring is available (as available as nitrogen in chemical fertilizer) in the year of application. In the second year approximately 10 percent of the remaining nitrogen becomes available, 5 percent in the third year and 2 percent in the fourth year. Thus if 20 tonnes of cattle manure per hectare were applied, the amount of nitrogen available in the first year would be 48 kg N/ha (Table 5). This is approximately one half of the total nitrogen content. The amounts of available nitrogen in years 2, 3 and 4 would be 5, 2 and 1 kg N/ha, respectively. For example, if 20 tonnes of cattle manure were applied each year for four years, the total available nitrogen from the manure in the fourth year would be 48 + 5 + 2 + 1 = 56 kg N/ha.

Manure also contributes micronutrients and organic matter to the soil which can be a significant benefit in fields not regularly receiving manure.

Time and Method of Application

For most effective use of the nitrogen in manure it should be applied in the spring and covered with soil the same day to prevent loss of ammonia. Immediate covering with soil is estimated to provide 25% more nitrogen to the crop than where the same manure is not covered immediately. Most of the nitrogen loss to the air occurs within the first week after application. Injection of manure between corn rows after seeding, but before the corn is 30 cm high, is one way of preventing nitogen loss and minimizing the potential for pollution of adjacent streams with phosphate from surface runoff. However phosphate applied after a crop is seeded may not be available to that crop. Phosphate fertilizer requirements should therefore not be adjusted for manure applied after seeding.

Where the manure is applied in the fall more nitrogen is lost (to the air and by leaching) than when applied in spring. The nitrogen adjustments should be 50% lower for fall applied manure than for spring-applied manure which is not immediately covered (see table). Phosphate and potash are believed to be equally available from fall and spring-applied manure.

If manure must be spread in the winter, nitrogen adjustments should be the same as for fall applied. **Do not spread manure in winter or early spring on fields that are subject to runoff.** If ponding occurs during spreading of liquid manure on tile drained fields, there is a possibility that some manure will enter the tile.

Manure Density in Spreader

The amount of manure applied depends on the volume of the spreader, spreading width, distance travelled and manure density in the spreader. The density for heavily bedded or very dry manure is approximately 400 kg/m^3 (25 lb/ft^3) while that for semi-solid or liquid manure is 1000 kg/m^3 (62 lb/ft^3). Thus, depending on bedding and water content, the density of manure in a spreader will vary between these values.

Manure Analysis

The nutrient content of manure varies not only with the type of livestock but with their ages, the ration fed, the type of bedding or amount of water added and the method of storing the manure. Chemical analyses will indicate more accurately than this publication the amount of nutrients available for crop production from the particular manure you intend to use, provided a representative sample can be obtained. For liquid manure, proper sampling requires that the tank contents be well mixed before a sample is taken. For solid manure, a representative sample can be obtained by taking forkfuls from different places on the stack (not from surface), mixing well and then taking a sample (about 1-2 kg) for submission to a laboratory. A manure analysis may be obtained from several labs in Ontario.

Table 6. Soil pH at Which Lime is Recommended for Ontario Field Crops

Crops	Soil pH Below Which Lime is Recommended	Target Soil pH*
Coarse and Medium Textured Mineral Soils (sand, sandy loams, loams and silt loams)		
Perennial legumes, oats barley, wheat, triticale, beans, peas, canola, flax	6.1	6.5
Corn, soybeans, rye, grass hay, pasture and tobacco	5.6	6.0
Fine Textured Mineral Soils (clays and clay loams)		
Alfalfa	6.1	6.5
Other perennial legumes, oats barley, wheat, triticale, soybeans, beans, peas, canola, flax	5.6	6.0
Corn, rye, grass hay pasture and tobacco	5.1	5.5
Organic soils (peats and mucks)		
All field crops	5.1	5.5

**Where a crop is grown in rotation with other crops requiring a higher pH (for example corn in rotation with wheat or alfalfa) it is recommended that the soil be limed to the higher pH.*

SEWAGE SLUDGE

Sewage sludge is a useful source of nitrogen, phosphorus and organic matter, provided it is low in heavy metals and applied under approved conditions. Consult OMAF Factsheet, *How and Where to Use Sewage Sludge in Crop Production*; Agdex 100/541.

SOIL ACIDITY AND LIMING

The pH scale ranging from 0 to 14 is used to indicate acidity and alkalinity. A pH value of 7.0 is neutral; values below 7.0 are acid and those above 7.0 are alkaline. Most field crops grow well in a soil pH range from 6.0 to 8.0.

To correct soil acidity ground limestone should be broadcast and worked into the soil at rates determined by soil test. Table 6 shows the pH values below which lime is recommended and the target soil pH to which soils should be limed, for different crops. In Ontario most crops grow quite well at pH values higher than the target pH to which lime is recommended.

The Buffer pH

Different soils with any one soil pH value, say 5.2, will require different amounts of lime to bring the pH to a particular desired level, say 6.0, depending chiefly on the clay and organic matter content of each soil. The soil pH is used to determine which soils need to be limed but a separate soil test, the buffer pH, is run on soils needing lime to determine the amount of lime required. For soils needing lime (based on soil pH) Table 7 may be used to determine the amount of lime required to reach different "target" soil pH values required for different crops.

Limestone Quality

Calcitic limestone consists largely of calcium carbonate, and dolomitic limestone is a mixture of both calcium and magnesium carbonates. Dolomitic limestone should be used on soils with a magnesium soil test of 100 or less as it is an excellent and inexpensive source of magnesium for acid soils. On soils with magnesium tests greater than 100, calcitic or dolomitic limestone may be used.

Table 7. Lime Requirements to Correct Soil Acidity Based on Soil pH and Soil Buffer pH.

Buffer pH	Target soil pH = 6.5 pH below 6.1	Target soil ph = 6.0 pH below 5.6	Target soil pH = 5.5 pH below 5.1
Ground limestone required - t/ha (Based on an Agricultural Index of 75)			
7.0	2	1	1
6.9	2	1	1
6.8	2	1	1
6.7	2	2	1
6.6	3	2	1
6.5	3	2	1
6.4	4	3	2
6.3	5	3	2
6.2	6	4	2
6.1	7	5	2
6.0	9	6	3
5.9	10	7	4
5.8	12	8	4
5.7	13	8	5
5.6	15	11	6
5.5	17	12	8
5.4	19	14	9
5.3	20	15	10
5.2	20	17	11
5.1	20	19	13
5.0	20	20	15
4.9	20	20	16
4.8	20	20	18
4.7	20	20	20
4.6	20	20	20

Two main factors affect the value of limestone for soil application. One of these is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. This is called the "neutralizing value" and is expressed as a percentage of the neutralizing value of pure calcium carbonate. A limestone which will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. In general, the higher the calcium and magnesium content of a limestone the higher the neutralizing value.

The second factor which affects the value of limestone as a neutralizer of acidity is the particle size. Limestone rock has much less surface area to react with acid soil than finely powdered limestone and, hence, it neutralizes acidity much more slowly; so slowly that it is of little value. The calculation of a fineness rating for ground limestone is illustrated in Table 8.

Table 8. Example Calculation of the Fineness Rating of a Limestone

Particle Size	% of Sample	Effectiveness Factor	
Coarser than no. 10 sieve[1]	10	× 0 =	0
no. 10 to no. 60 sieve	40	× 0.4 =	16
Passing through no. 60 sieve	50	× 1.0 =	50
Fineness Rating		=	66

[1] *A no. 10 Tyler sieve has wires spaced 2.0 mm, and a no. 60 Tyler sieve has wires spaced 0.25 mm apart.*

The Agricultural Index

Some means of combining the Neutralizing Value and the Fineness Rating is needed to compare various limestones that are available. The index which has been developed in Ontario to do this is called the "Agricultural Index."

$$\text{The Agricultural Index} = \frac{\text{neutralizing value} \times \text{fineness rating}}{100}$$

The Agricultural Index can be used to compare the relative value of different limestones for neutralization of soil acidity. Lime with a high Agricultural Index is worth proportionately more than lime with a low index because it may be applied at a lower rate. If two ground limestones, A and B, have Agricultural Indices of 50 and 80 respectively, the rate of application of limestone A required for a particular soil will be 80/50 × the rate required for limestone B. Limestone A spread on your farm is worth 50/80 × the price of limestone B per tonne.

Recommendations from the OMAF soil test service are based on limestone with an Agricultural Index of 75. If you know the Agricultural Index, you can calculate a rate of application specifically for limestone of that quality. This can be done using the following equation:

$$\begin{array}{c}\text{Limestone}\\\text{application}\\\text{rate from soil}\\\text{test}\end{array} \times \frac{75}{\begin{array}{c}\text{Agr. Index}\\\text{of your limestone}\end{array}} = \begin{array}{c}\text{rate of}\\\text{application}\\\text{of your limestone}\end{array}$$

For example, if you have a limestone requirement by soil test of 9 t/ha, and your most suitable source of limestone from a quality and price standpoint has an Agricultural Index of 90, you should apply 75/90 × 9 = 7.5 t/ha.

The Agricultural Index does not provide information about magnesium content. Dolomitic limestone should be used on soils low in magnesium.

Liquid Lime

"Liquid lime" is advertised and occasionally sold in Ontario often at very high costs in relation to the neutralizing value. This is very fine ground limestone suspended in water. It is equivalent to finely ground dry lime in availability and would have a "fineness" rating of 100. When diluted with water the neutralizing value will be low per unit of weight resulting in the need for high rates of application. Note that in the fineness rating lime passing through a 60 mesh screen is considered to be 100% effective. Limestone ground finer than this is not considered to be any more effective.

Tillage Depth

Lime recommendations presented here should raise the pH of the top 15 cm of a soil to the listed target pH. If the soil is ploughed to a greater depth than 15 cm proportionately more lime is required to reach the same target pH. Since lime moves very slowly in soils it should be incorporated to 15 cm depth where practical.

Lowering Soil pH

On soils with pH values below 7.0 it is possible to lower the pH (make the soil more acid) by adding sulfur or ammonium sulfate, but this is not advisable for most crops as it only hastens the time when lime will be required. If the soil pH is above 7.0 it is not advisable and also usually quite impractical to lower the soil pH because of the very large amounts of sulfur or ammonium sulfate required.

SOIL MAGNESIUM

Magnesium is a plant nutrient which is naturally plentiful in many Ontario soils. Soils with magnesium soil tests below 20 (OMAF soil test) require magnesium application for production of most crops. Very few Ontario soils have magnesium tests below 20. If the soil pH is below 6.0, the most effective and inexpensive means of supplying magnesium is by application of dolomitic lime. If the pH is above 6.0, and the soil test 20 or below, magnesium can be supplied by either magnesium sulfate or sulfate of potash magnesia, which is a mixture of sulfate of potash and magnesium sulfate. Apply 30 kg/ha of actual soluble magnesium. These latter sources of magnesium are usually quite expensive compared to supplying magnesium from dolomitic limestone.

Potassium competes with magnesium for uptake by crops, and potash applications can therefore induce or increase magnesium deficiency. For this reason it is important to monitor soil potassium levels and to carefully control potash fertilizer applications on low magnesium soils.

Crops grown on a number of Ontario soils are low in magnesium to an extent that livestock health is affected although the crops themselves do not suffer from magnesium deficiency. In these situations it is usually much less costly to add magnesium to the animal's diet than to add it to the soil. Soil potassium should be closely monitored, however, and potash applications restricted to requirements as measured by soil test.

FERTILIZER MATERIALS

Nitrogen fertilizer materials are available in dry or liquid forms. Although there are some limitations to use of these materials (see section, *Toxicity of Fertilizer Materials*), in most cases the different sources will produce equal yields. The farmer's choice of material should therefore depend on availability, equipment for handling, and cost per kilogram of nitrogen, plus the cost of application.

A farmer should first calculate the cost per kilogram of nitrogen for various sources delivered to his farm. Depending on the rate of application, the cost per hectare can be determined. Add to this the cost of application per hectare before deciding which nitrogen source to use.

Where separate additions of nitrogen are referred to in the recommendations, kilograms of elemental nitrogen (N), not kilograms of materials, are used. The following tables show the percentage of fertilizer nutrient contained in different materials.

Various fertilizer companies have available, in addition to the micronutrient sources listed in Table 10, premixes containing one or more micronutrients.

Individual Factsheets are available on some of these micronutrients. For a list of these see Publications section.

Table 9. Fertilizer Materials – Primary Nutrients

Nitrogen Materials	**Form**	**% Nitrogen (N)**
Ammonium nitrate	Dry	33 to 34
Urea	Dry	45 to 46
Ammonium sulfate	Dry	20
Aqua ammonia	Liquid[1]	20
Ammonium nitrate-urea	Liquid	28
Ammonium nitrate-urea	Liquid	32
Ammonia ammonium nitrate-urea	Liquid[1]	41
Ammonia-ammonium nitrate	Liquid[1]	41
Anhydrous ammonia	Liquid[1]	82
Phosphate Materials		**% Phosphate (P_2O_5)**
Single superphosphate		20
Triple superphosphate		44 to 46
Monoammonium phosphate		48 to 52
Diammonium phosphate (18-46-0)		46
Potash Materials		**% Potash (K_2O)**
Muriate of potash		60 to 62
Sulfate of potash		50
Sulfate of potash magnesia (11% Mg)		22
Potassium nitrate (13-0-44)		44

[1] *Liquid under pressure.*

Table 10. Fertilizer Materials – Secondary and Micronutrients

Magnesium (Mg)	
Dolomitic Limestone	6-13% Mg
Epsom Salts (Magnesium sulfate)	10.5% Mg
Sulfate of Potash Magnesia	11% Mg
Boron (B)	
Sodium Borate	12-21% B
Copper (Cu)	
Copper Sulfate	13-25% Cu
Copper Chelates	5-13% Cu
Manganese (Mn)	
Manganese Sulfate	26-28% Mn
Manganese Oxysulfate	28% Mn
Manganese Chelates	5-12% Mn
Molybdenum (Mo)	
Sodium Molybdate	39% Mo
Zinc (Zn)	
Zinc Sulfate	36% Zn
Zinc Chelates	7-14% Zn
Zinc Oxysulfate	18-36% Zn

SOLUBLE SALTS IN FARM SOILS

High concentrations of water soluble salts in soils can prevent or delay germination of seeds and can kill established plants or seriously retard their growth.

Ontario soils are naturally low in soluble salts. Soluble salts therefore rarely cause a problem in crop production and are not routinely measured in soil tests.

Soluble salts in soils can result from excessive applications of fertilizers and manures, runoff of salts applied to roads, and chemical spills on farm land. High concentrations of soluble salts in or near a fertilizer band can cause serious temporary problems, affecting seed germination and/or early plant growth without seriously affecting the salt concentrations in the remainder of the soil. A given amount of salt in a soil provides a higher salt concentration in soil water if the amount of water is small. Soluble salts also interfere with the uptake of water by plants. For these reasons plant growth is most affected by soluble salts in periods of low moisture supply (during drought periods).

Soluble salts can be measured readily in the laboratory by measuring the electrical conductivity of a soil water slurry. The higher the concentration of water soluble salts the higher the conductivity. The following table provides an interpretation of soil conductivity readings as read in Ontario field soils in a 2:1 water: soil paste, the procedure used by the OMAF soil testing service.

Table 11. Soil Conductivity Reading Interpretation

Conductivity "salt" reading millisiemens/cm	Rating	Plant Response
0-0.25	L	Suitable for most plants if recommended amounts of fertilizer are used.
0.26-0.45	M	Suitable for most plants if recommended amounts of fertilizer are used.
0.46-0.70	H	May reduce emergence and cause slight to severe damage to salt sensitive plants.
0.71-1.00	E	May prevent emergence and cause slight to severe damage to most plants.
1.00	E	Expected to cause severe damage to most plants.

For greenhouse soils the OMAF soil test uses a larger soil sample and measures conductivity on a saturation extract. For greenhouse crops using that method conductivity readings up to 3.5 millisiemens/cm are acceptable.

TOXICITY OF FERTILIZER MATERIALS

All fertilizer salts are toxic to germinating seeds and to plant roots if applied in sufficient concentration near the seed. Fertilizers vary in toxicity per unit of plant nutrient due to: (1) differences in the amount of salts contained in the fertilizer per unit of plant nutrient, (2) differences in solubility of the salts in the soil, and (3) a few specific materials or elements are particularly toxic (for example, anhydrous ammonia and boron). Phosphate fertilizers are usually low in toxicity because a large portion of the phosphate is precipitated in the soil before it can reach the plant roots. The concentration of phosphorus in soil solution at any one time is very low.

Nitrogen Fertilizers

Ammonium nitrate, monoammonium phosphate and ammonium sulphate are similar in toxicity and much safer than anhydrous ammonia, aqua ammonia or urea. Diammonium phosphate is more toxic than monoammonium phosphate but less toxic than urea. More care should be taken, particularly with sensitive seeds and on coarse-textured soil (sand and sandy loam), than is required with ammonium nitrate, or monoammonium phosphate.

Because anhydrous ammonia and aqua ammonia are extremely toxic fertilizers, they should not be placed near seeds. It is preferable to make pre-plant applications crossways to the direction in which the crop will be planted.

Urea is toxic when banded with or near the seed but is safe when broadcast at rates normally used. Fertilizers containing more than half as much nitrogen as phosphate frequently contain urea.

Phosphate Fertilizers

Most common phosphate fertilizers are not very toxic to seeds and plants and no limit is normally set for the safe rate which may be applied with, or near, the seed of field crops.

Diammonium phosphate is more toxic than other phosphate fertilizer – see above under nitrogen fertilizers.

Potash Fertilizers

Muriate of potash (KCL) is the most common source of potassium in fertilizers, and is less toxic per unit of plant nutrients than most nitrogen fertilizers.

Sulphate of potash (K_2SO_4) is less toxic than muriate of potash.

Sulphate of potash-magnesia has approximately the same toxicity per unit of potassium as muriate of potash.

Potassium nitrate is one of the safer sources of potassium.

Fertilizers Containing Micronutrients

Fertilizers containing micronutrients (boron, copper, iron, manganese or zinc) are more toxic than the same grades without micronutrients and maximum safe rates should be reduced. Boron is particularly toxic, and should be applied with caution particularly when banded.

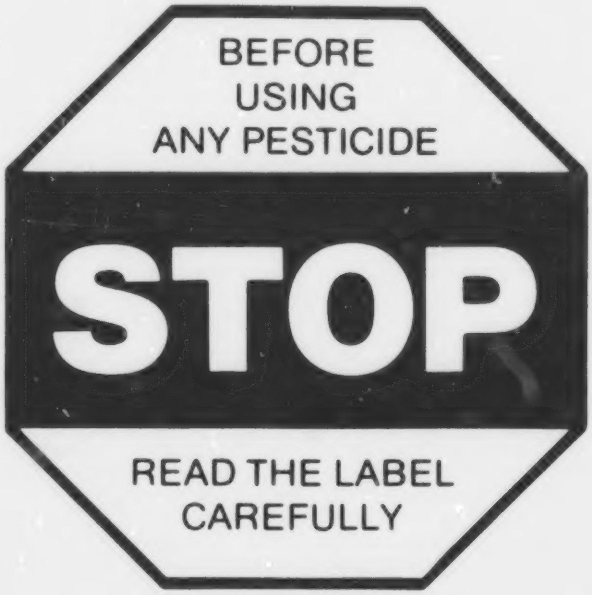

Table 12. Maximum Safe Rates of Nutrients

SPRING OATS AND BARLEY (fertilizer with the seed)	
Sands and Sandy Loam Soils	35 kg nitrogen or 55 kg (nitrogen + potash) per hectare. If **diammonium phosphate** (18-46-0) is the N source, 20 kg nitrogen or 35 kg (nitrogen + potash) per hectare. If urea is the N source, 10 kg nitrogen or 30 kg (nitrogen + potash) per hectare[1].
Loams, Silt or Clay Loams	45 kg nitrogen or 70 kg (nitrogen + potash) per hectare. If **diammonium phosphate** (18-46-0) is the N source, 30 kg nitrogen or 55 kg (nitrogen + potash) per hectare. If urea is the N source, 10 kg nitrogen or 30 kg (nitrogen + potash) per hectare[1].
WINTER WHEAT, TRITICALE OR BARLEY (fertilizer with the seed)	
All Soils	15 kg nitrogen or 30 kg (nitrogen + potash) per hectare. **Diammonium phosphate** (18-46-0) or **urea** should not be drilled with the seed of fall-seeded cereals[1].
CORN (fertilizer with the seed)	
All Soils	7 kg (nitrogen + potash) per hectare in one metre rows. **Diammonium phosphate** or **urea** should not be applied with the seed of corn. At row widths other than one metre, the rate may be adjusted to provide the same maximum concentration in the row (in 50 cm rows the safe rate = 100/50 × 7 = 14 kg (nitrogen + potash) per hectare).
CORN (fertilizer banded 5 cm to the side and 5 cm below the seed)	
All Soils	55 kg nitrogen or 90 kg (nitrogen + potash) per hectare. If **urea** is the N source, 30 kg nitrogen or 60 kg (nitrogen + potash) per hectare. At row widths other than one metre, the rate may be adjusted to provide the same maximum concentration in the row (in 50 cm rows the safe rate = 100/50 × 55 = 110 kg N per hectare).
CORN (fertilizer broadcast)	
Sands and Sandy Loam Soils	If urea is the N source, 200 kg nitrogen or 250 kg (nitrogen + potash) per hectare.
CANOLA (fertilizer with the seed)	
	up to 20 kg/ha phosphate fertilizer may be drilled with the seed as superphosphate or monoammonium phosphate. Nitrogen (except in the form of monoammonium phosphate) and potash should not be applied with the seed.
CANOLA (fertilizer banded no less than 2 cm to the side and 2 cm below the seed)	
	30 kg/ha of nitrogen or 50 kg/ha (nitrogen + potash) along with all the phosphorus required. Urea should not be banded.
FLAX (no fertilizer with seed)	
All soils	Rates recommended are normally safe when broadcast.
PEAS, BEANS AND SOYBEANS (no fertilizer with seed)	
All soils	(fertilizer banded 5 cm to the side and 5 cm below the seed) 30 kg nitrogen or 90 kg (nitrogen + potash) per hectare. Rates recommended are normally safe when broadcast.

[1] *Fertilizers containing more than half as much nitrogen as phosphate (e.g. 16-16-16) frequently contain urea. Note that fertilizers containing urea are not suitable for banding at seeding in many cases.*

Guidelines for Safe Rates of Nutrients Applied at Seeding

Fertilizer toxicity varies widely, depending on the amount of soil moisture. To insure completely safe rates of banded fertilizer for all seeding conditions would require extremely low rates of application. The maximum safe rates suggested here will probably reduce or delay germination, or retard growth in up to 10% of the cases where they are used. In most cases, it is advisable to use lower rates of fertilizer at seeding than those listed in the following table. If fertilizer requirements are high, it may be better to broadcast most of the fertilizer required and to band only a small portion at seeding. Fertilizers containing the micronutrients boron, copper, iron, manganese and zinc are more toxic, and the safe rates recommended will be lower than those shown in this table.

CORN

CROP MANAGEMENT

Seeding Date and Planting Depth

The best yields are usually obtained from corn planted in the first half of May because the crop is able to use the full growing season. Early planting also results in earlier maturity in the fall, reducing the risk of damage from an early fall frost or adverse weather at harvest. The optimum planting date is around May 7 in southwestern Ontario and May 10 in central and eastern Ontario. Delaying planting past the optimum date can result in yield reductions averaging 40 kg/ha per day of delay.

It is advisable to start planting slightly before the optimum date. Take advantage of good planting conditions when they occur. The risk of a yield reduction from planting a bit too early is less than that from planting too late.

Corn will germinate if the soil temperature is over 10C, but emergence will be very slow at soil temperatures under 15C. When planting early or in cold soil, place the seeds 2 to 3 cm deep, because the soil will be warmest near the soil surface. Deeper planting will result in delayed emergence and uneven stands.

When planting in warm soil, the seeding depth generally should be such that the seed is placed in moist soil. Excessively deep planting should be avoided. Seeds planted more than 7 cm deep may have difficulty emerging, especially on fine-textured or compacted soils where crusting may be a problem.

Plant Populations

The plant populations discussed here are suggested final plant stands. Because not all seeds emerge, it is necessary to seed at slightly higher rates. When planting early in the season or when the soil is cold, a seeding rate 10% higher than the desired final stand is recommended (see Table 13). When soils are warmer, an adjustment of 5% is sufficient.

In Ontario, corn has commonly been grown at populations of 52,000 to 58,000 plants per hectare. These populations can produce good yields over a wide range of growing conditions without excessive lodging. In recent years, hybrids have been developed which tolerate higher plant densities without excessive lodging or barrenness. Under good growing conditions, higher yields can be obtained by using plant populations as high as 67,000 plants per hectare.

Increased plant densities are not appropriate for all situations because of the many factors that interact with plant population to place the crop under stress. Factors such as drought, weeds, insects, diseases, soil compaction, inadequate fertility and poor drainage all serve to exaggerate the stressful effects of increased plant populations. The more severe these other stresses are, the lower the optimum plant population will be.

Yield increases from increased plant densities have been least in the warmer parts of Ontario (over 2900 heat units for grain corn or 3100 heat units for whole-plant silage). Many factors, including larger plant size and higher temperatures at silking, are responsible for this difference. In these warmer areas, optimum plant populations will be lower than those discussed below.

Hybrid selection is a critical factor in determining the optimum plant population. Many hybrids yield well at 55,000 plants per hectare, but cannot tolerate higher densities, especially if growing conditions are less than ideal. Only a few hybrids can tolerate a population of 67,000 plants per hectare. The population selected must be suitable for the hybrid being grown and the growing conditions likely to be encountered. If may be necessary to change the plant population when changing hybrids or fields.

Experience with previous corn crops can provide guidelines for choosing a plant population. Where yields have been low and lodging a problem, even though good-standing hybrids have been grown, final stands as low as 50,000 plants per hectare are recommended. These lower populations should be considered on soils low in fertility, susceptible to drought, imperfectly drained, or otherwise in poor condition.

An increase in plant density is most likely to result in improved grain yield in fields that already have a history of high yields with little lodging. These will be fertile, well-drained fields with good moisture-holding capacity. In such cases, consideration should be given to increasing plant population. There appears to be little advantage to plant densities over 67,000 plants per hectare for grain corn.

A benefit from higher plant densities will most likely be obtained when corn is planted early. Later plantings result in large, leafier plants and more inter-plant competition. Late-planted corn will also be silking later when the risk of drought or heat-stress is greater. Therefore, plant density should be reduced as planting is delayed.

Because lodging is of less concern in corn grown for whole-plant silage, higher plant populations can be used than for grain corn. In areas with less than 3100 heat units, final stands of 60,000 to 70,000 plants per hectare will produce higher silage yields with little effect on the grain content or moisture level of the silage. These populations should be used only where it is certain that the field will be harvested for whole-plant silage. Fields left for grain at these densities could lodge excessively. Even for silage, the population should not exceed 60,000 plants per hectare on soils that are droughty or otherwise in poor condition.

Table 13. Centimetres Between Seeds to Achieve Specific Populations

Final[1] Plants/ hectare	Seeds[2] Per hectare	Row Width[3] — centimetres						
		71	76	81	86	91	97	102
40,000	43,900	32	30	28	26	25	23	22
45,000	50,000	28	26	25	23	22	21	20
50,000	55,600	25	24	22	21	20	19	18
55,000	61,100	23	22	20	19	18	17	16
60,000	66,700	21	20	19	17	16	15	15
65,000	72,200	20	18	17	16	15	14	14
70,000	77,800	18	17	16	15	14	13	13

[1] *1 hectare = 2.47 acres*

[2] *Based on 10% loss of plants. With planting after the optimum date, a loss of 5% of the plants may be more realistic.*

[3] *1 centimetre* = 0.39 inches.

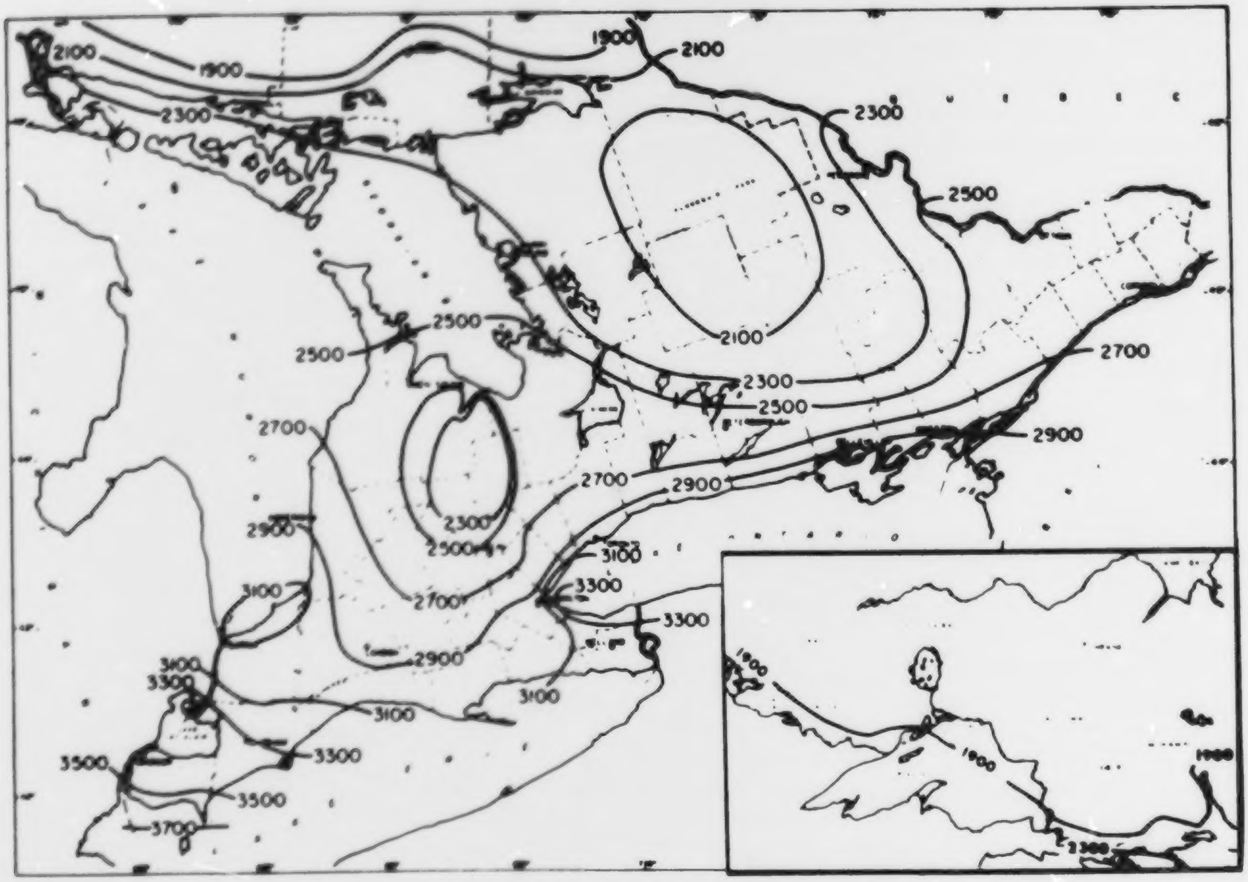

Figure 1. Heats Units Available for Corn Production

HYBRID SELECTION

Grain Corn

Corn hybrids suitable for Ontario are evaluated for yield, maturity and standability in tests conducted across the province each year. The results are published annually in the *Ontario Hybrid Corn Performance Trials* report. This report is a valuable guide in selecting hybrids. The first consideration in choosing a hybrid must be the ability to reach the proper stage of maturity in the fall. Once the maturity range is established, the final selection should be based on both yield and standability.

Silage Corn

Experience has demonstrated that hybrids producing high grain yields also produce high silage yields. When choosing hybrids specifically for whole-plant silage, a yield advantage can usually be obtained by selecting hybrids rated 100 to 200 heat units later than those selected for grain.

Choosing Hybrids for Your Farm

Locate the vicinity of your farm on the map in Figure 1 and estimate the number of heat units available. Since the number of heat units received will also be influenced by the slope, elevation and soil type, the average heat units received by a farm may vary over the long term from the estimate by up to 50 heat units. Once you have established the heat unit rating for your farm, select hybrids requiring that number of heat units or fewer. This should ensure that corn planted by mid-May will reach full maturity before a killing frost nine years out of ten.

If planting is delayed beyond mid-May, reduce your estimate of the number of heat units available by 100 for each week that planting is delayed. For example, in a 2900 heat unit area, if planting is delayed to May 24, select a hybrid that requires no more than 2800 heat units to mature.

FERTILIZERS FOR CORN

Nitrogen

The nitrogen rates recommended in Table 14 represent the most profitable rate of application at various yield levels across Ontario. The expected yield is that which from previous experience, you can expect on your farm in a normal year.

Rates should be adjusted downward if the preceding crop was a legume sod (See *Adjustments for Legumes Plowed Down* in *Soils section*) or if manure is applied (see *Manure* in *Soils section*).

The most profitable rate of nitrogen application is also affected by the relative prices of corn and nitrogen, expressed as a corn/

nitrogen price ratio. This ratio is calculated by dividing the selling price of corn, in dollars per tonne, by the cost of nitrogen, in dollars per kilogram of actual N.

To determine the cost per kilogram of actual nitrogen, divide the cost per tonne of fertilizer material by ten times the percentage of nitrogen.

$$\text{Cost of N/kg} = \frac{\text{Cost of Nitrogen Fertilizer per tonne}}{10 \times \%\ \text{Nitrogen in Fertilizer}}$$

Table 14. Nitrogen Recommendations for Corn

	Expected Yield (t/ha)					
Grain (Silage)	**5 (25)**	**6 (30)**	**7 (35)**	**8 (40)**	**9 (45)**	**10 (50)**
Region[1]	**Most profitable nitrogen rate kg actual N/ha**					
Eastern Ontario	70	90	110	130	155	175
Western and Central Ontario	80	100	110	120	125	135
Southwestern Ontario (Preplant)	145	160	175	185	190	195
Southwestern Ontario (Sidedress)	125	140	145	150	155	160

100 kg/ha = 90 lb/ac

[1] *Eastern Ontario is that part of the corn growing area lying east of Kingston.*
Southwestern Ontario is that part of the province west of Toronto receiving more than 2800 corn heat units.
Western and Central Ontario are the remainder of the corn growing areas of Ontario.

The recommendations in Table 14 are based on a corn/nitrogen price ratio of 200. (For example, a corn price of $130 per tonne and a nitrogen cost of $0.65 per kilogram of nitrogen.)

If the ratio falls to 150, reduce the rates recommended in Table 14 by 20 kg/ha.

If the ratio should rise to 250, increase the rates in Table 14 by 15 kg/ha.

For more information on these calculations see OMAF Factsheet, *Nitrogen Recommendations for Corn*, Agdex 111/541.

Nitrogen Application

The major portion of the nitrogen should be applied in the spring, either preplant, pre-emergence, or side-dressed before the corn is 30 cm high. Fall application is not recommended because of the potential for high losses.

In southwestern Ontario, side-dressed applications have shown a slight yield advantage over pre-plant applications. In the rest of the province, there has been no yield advantage for side-dressed applications.

No yield differences have been found in Ontario when comparing the various nitrogen materials.

Solid forms of nitrogen or urea-ammonium nitrate solutions (UAN) may be applied to the soil surface without incorporation. However, urea or UAN applied on crop residues should be incorporated into the soil immediately. Under dry conditions, the effectiveness of all forms of nitrogen may be improved by incorporation.

If UAN solutions contact leaves, burning and yield reductions are likely to occur.

Anhydrous ammonia, applied with conventional equipment, should be placed a minimum of 15 cm deep in the soil. For preplant applications, applicator outlets should be no more than 50 cm apart. For wider spacings, a 4 day waiting period before planting is recommended to avoid damage to seedlings.

When appropriate equipment is used, ammonia may be applied with a cultivator or disc, a minimum of 10 cm deep with the ammonia outlets spaced no more than 50 cm apart.

Phosphate and Potash

Phosphate and potash requirements for corn are presented in Table 15.

For information on use of this table see *Fertilizer Recommendations* in *Soils Section.*

The major portion of the phosphorous and potassium may be broadcast and plowed or worked into the soil either in the fall or spring. However, where soil tests show a requirement for these nutrients a fertilizer containing nitrogen and phosphorus or nitrogen, phosphorus and potassium should be applied as a starter at planting time. For further information see Table 12 ***Maximum Safe Rates of Nutrients*** in the *Soils* section.

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre.

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Table 15. Phosphate and Potash Requirements for Corn Based on OMAF Soil Tests

Sodium Bicarbonate Phosphorus Soil Test (ppm)	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Ammonium Acetate Potassium Soil Test (ppm)	Rating	Potash (K_2O)[1] Required kg/ha
0 - 3		110	0 - 15		170
4 - 5	LOW	100	16 - 30	LOW	160
6 - 7		90	31 - 45		140
8 - 9		70	46 - 60		110
10 - 12		50	61 - 80		80
13 - 15	MEDIUM	20	81 - 100	MEDIUM	50
16 - 20		20	101 - 120		30
21 - 30	HIGH	20	121 - 150	HIGH	0
31 - 60	VERY HIGH	0	151 - 250	VERY HIGH	0
61 +	EXCESSIVE[2]	0	251 +	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac.

[1] *Where manure is applied, reduce fertilizer applications according to the amount and quality of manure (See Manure section in Soils).*

Sample Calculation:
If the expected yield of grain corn in a field in western Ontario is 7 t/ha, the nitrogen recommendation would be 110 kg/ha. (See Table 14.) If the soil tests are 11 for phosphorus and 110 for potassium, the phosphate requirement would be 50 kg/ha and the potash requirement 30 kg/ha. (See Table 15). The phosphate could be supplied by 160 kg/ha of 8-32-16 (50 X 100 / 32 = 160). This would also supply 12 kg/ha of nitrogen and 25 kg/ha of potash. The remaining 98 kg/ha of nitrogen could be supplied by 120 kg/ha of ammonia (98 X 100 / 82 = 120).

[2] *When the soil test rating for a nutrient is "Excessive", application of this nutrient in fertilizer or manure may reduce crop yield or quality. For example, phosphorus applications may induce zinc deficiency, on soils low in zinc, and may increase the risk of water pollution. Potash applications on soils low in magnesium may induce magnesium deficiency.*

Plant Analysis

Sample the mid-third of the ear leaf at silking. However, plants suspected of nutrient deficiency should be sampled as soon as the problem appears. For plants with six leaves or less sample the total above ground plant. From seven leaves to silking sample the youngest fully developed leaf. Expert help will be required to interpret plant analysis results when the samples are not taken at silking.

Table 16. Interpretation of Plant Analysis for Corn[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen (N)	%	2.5	3.5
Phosphorus (P)	%	0.15	0.50
Potassium (K)	%	1.2	2.5
Calcium (Ca)	%	—	1.5
Magnesium (Mg)	%	0.10	0.60
Sulphur (S)	%	0.14	—
Boron (B)	ppm	2	25
Copper (Cu)	ppm	2	20
Manganese (Mn)	ppm	15	150
Zinc (Zn)	ppm	14	70

[1] *Values apply to the mid-third of the ear leaf sampled at silking.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

A soil sample should be taken from the same area and at the same time as a plant sample.

For more information on plant analysis see *Plant Analysis* section in *Soils.*

Micronutrients and Magnesium

Although magnesium is plentiful in most soils in Ontario, magnesium deficiency does occur on acid, sandy soils. The symptoms appear first as yellow striping of the lower leaves. As the deficiency worsens, the upper leaves may become striped while the lower leaves turn reddish-purple.

All soil samples analysed under the OMAF soil testing program are tested for magnesium. This test is a reliable guide for determining magnesium requirements.

Dolomitic lime is an excellent source of magnesium. Where limestone is required to correct soil acidity, dolomitic lime should be used whenever the magnesium test is less than 100. For further information, see OMAF Factsheet, *Soil Acidity and Liming*, Agdex 534.

Few soils that do not need lime will require magnesium. Magnesium application is recommended only if the magnesium test is under 20. On these soils magnesium can be supplied either by magnesium sulphate or, if potassium is also required, by sulfate of potash magnesia. Apply 30 kg/ha of water soluble magnesium.

Over-application of potassium can induce magnesium deficiency. For this reason it is important to monitor soil potassium levels closely, and restrict potash application rates to those recommended by the OMAF soil test.

Zinc deficiency occurs on corn in Ontario. Visual symptoms on the leaves are the best means of determining deficiency but soil tests are also useful. Response to zinc should not be expected unless deficiency symptoms are quite marked.

When zinc is required it may be applied to the soil mixed in the fertilizer at rates supplying 4 to 14 kg zinc/ha. The higher rate should be sufficient for up to 3 years. Not more than 4 kg zinc/ha should be banded at planting. Zinc may be applied as a foliar spray at rates supplying 60 g zinc/100 litres (0.6 lb/100 gal). A wetting agent should be added. Spray to leaf wetness. For further information, *see Micronutrients* in *Soil Management* section and OMAF Factsheet, *Zinc Requirements for Field Crops*, Agdex 100/531.

Other micronutrients are not likely to be deficient on corn in Ontario.

DISEASE AND INSECT CONTROL IN CORN

(see also Pesticides section)

Seed Treatment

Follow the precautions under *Seed Treatments* in *General Information on Pesticide Usage* section, when applying chemical seed treatment.

Seed corn sold in Ontario has been treated with a fungicide, such as captan, Vitaflo 280 or thiram, for protection against **seed decay** organisms. A treatment may also have been applied to control insects that attack seed in storage

Additional treatments to protect seeds from soil-inhabiting insects should be applied every year. Use diazinon to reduce damage by **seed maggots** and lindane for protection from **wireworms**. Seed treatment combinations of diazinon and lindane are available from seed suppliers and should be applied as recommended. Follow the directions on the label with care. Thorough mixing is important.

Apply insecticides to the seed just before planting or mix them with seed in the planter box. Use a wooden paddle to mix the chemicals and seed.

DISEASES

General Preventive Measures

1. Plant hybrids resistant to leaf blights and stalk rot (see below and check with seed company).
2. Rotate corn with other crops to help prevent disease buildup. Rotation is particularly important when reduced tillage is practised.
3. Chopping of corn stalks and leaves, and plowing under of the residues, help to kill overwintering disease fungi.
4. Minimize plant stress by:
   a. Avoiding plant populations that are too high for the hybrid grown.
   b. Maintaining high soil fertility, good soil structure, and good drainage.

Leaf blights Northern leaf blight and leaf spot sometimes appear, especially on lower leaves. Both diseases are favored by moderate temperatures, long dew periods, and rain. Most recommended hybrids have good resistance. See OMAF Factsheet, *Leaf Diseases of Field Corn*, Agdex 111/632.

Eyespot is usually severe only in wet seasons in fields with much corn debris from the previous season or on highly susceptible hybrids. Crop rotation and clean plowing of corn debris help to reduce disease severity.

Anthracnose is now widely distributed in southern Ontario and may become severe in wet years. The disease may affect both leaves and stalks. Rotation of corn with other crops and plowing down corn residues cleanly will reduce disease severity. See OMAF Factsheet, *Leaf Diseases of Field Corn*, Agdex 111/632.

Bacterial leaf blight (Stewart's Wilt) occurs in southwestern Ontario, mainly in Essex and Kent counties. Elongate water-soaked streaks with wavy margins appear on the leaves, especially after silking. When disease develops earlier the plants may wilt. The disease can be transmitted in seed or by the corn flea beetle, and may spread from sweet corn which is more susceptible than field corn.

Common Smut Greyish smut galls up to 10 cm in diameter develop on the stalks, ears and tassels, while smaller galls often appear on the leaves. Stress from herbicides or drought, injury by hail, blowing sand or cultivation and high rates of nitrogen can increase smut incidence. Most corn hybrids have enough resistance to smut to prevent serious outbreaks. However, some smut is present in most fields.

Stalk Rot Grow hybrids with low stalk breakage counts, as listed in the current Ontario Hybrid Corn Performance Trials. Copies are available from your county office of the Ministry of Agriculture and Food. Stalk rot is often serious in fields with high plant populations, low fertility, and poor soil conditions. Harvest as early as possible because stalk rot develops mostly on mature plants and becomes a greater problem the longer the crop is left in the field.

Ear Rot Pink, white, green and black molds may develop on ears. The pink molds, and less often the white molds, may produce toxins, including estrogens and vomitoxin, which have serious effects on livestock, especially pigs and poultry. The green and black molds do not normally pose a problem except when, in great abundance, they may put livestock off feed. Development of the ear rot is stopped when corn is dried, or ensiled, but the level of harmful toxins, if present, remains unchanged. Where corn is stored in cribs these fungi will, under favorable weather conditions, continue to grow and produce toxin until corn moisture drops below 20%. See OMAF Factsheet, *Moldy Feeds and Swine Diseases*, Agdex 440/60.

When ear rot is present, the following storage and feeding precautions are advisable:

1. Exercise caution in feeding moldy corn, especially to hogs. Pink or reddish molds are particularly harmful.

2. For assistance with problems of moldy feeds, contact the county office of the Ontario Ministry of Agriculture and Food. It may be recommended that the feedstuff be analyzed for toxins.
3. Avoid cribbing corn with pink ear rot.

INSECTS

Corn Rootworms There are two species of corn rootworms that damage corn in Ontario. The northern corn rootworm is still the predominant species east of Kingston while the western corn rootworm is the predominant species west of Kingston.

The larval stage of these species feed on corn, causing damage by tunneling through and pruning roots from mid June to mid July. When fully grown the slender, white larvae are about 1.5 cm long. The northern adult is a plain yellow or green beetle about 0.5 cm in length; the western adult is yellow with black markings and is slightly larger than the northern adult. Both adults feed on corn silks from August to the first frost. Field corn can withstand heavy adult populations (up to 10 adults per ear) at pollination without economic loss. After pollination is complete, beetle feeding no longer poses a threat to yield. See OMAF Factsheet, *Corn Rootworms*, Agdex 111/622.

Crop rotation is recommended to control both species of rootworms. If crop rotation is not practical and the western corn rootworm is predominant in your area, it may be necessary to treat 2nd-year corn, especially on clay soils. If extensive goosenecking occurs, consider treatment with insecticide the following spring. Use a planter-mounted granular insecticide applicator with a spreader attachment to place an insecticide in at least a 15-cm band in front of the press wheel but not in contact with the seed because of possible phytotoxicity. Calibrate the applicator each year, when switching chemicals or changing planting speeds. Do not use a broadcast application. To avoid wind drift and poor control, mount the spreaders as close to the ground as possible, and use wind guards. Any one of the following insecticides may be used. Consult the insecticide label for manufacturer's directions for use.

Poor control has often been the result of:

1. Poor calibration.
2. Applying less than recommended rates.
3. Poorly maintained equipment.
4. Absence of wind guards for proper placement of insecticide on windy days.

Under light to moderate rootworm pressures all of the insecticides listed below have significantly reduced the damage caused by corn rootworms. Under heavy insect pressures the **approximate** order of effectiveness is as listed below.

There is concern that the continued use of one material may result in development of corn rootworms resistant to, or soil microorganisms capable of rapid degradation of that insecticide.

All of these insecticides are extremely poisonous to the operator. Handle with care. Follow all safety precautions on the label. Only purchase what is needed for one year. Store under lock and key and not with food or animal feed. For additional information see Pesticides section.

Table 17. Corn Rootworm Control

	Rate of Product		
Insecticide Applied in a 15 cm band	**Grams per 100m of row Any Row Width**	**kg/ha at Row Width of**	
		90 cm	**75 cm**
Counter 15 G[1]	75	8.3	10.0
Dyfonate 20 G[2]	55	6.1	7.3
Lorsban 15 G[3]	75	8.3	10.0
Thimet 15 G	75	8.3	10.0
Furadan 10 G	110	12.2	14.6
Di-Syston 15 G	75	8.3	10.0
720 LC[4]	15 mL	1.6 L/ha	2.0 L/ha
Dasanit 15 G	75	8.3	10.0
Cygard 15 G[5]	75	8.3	10.0

G (Granular); LC (Liquid Concentrate).

[1] *Also controls seed corn maggot and wireworms. May also be applied directly in the seed furrow.*

[2] *Also controls seed corn maggot.*

[3] *Placement behind the planter shoe and ahead of the press wheel improves performance.*

[4] *Liquid concentrate must be sprayed in a 15-cm band for control. Do not apply with liquid starter fertilizer because the band is not wide enough for control of rootworms.*

[5] *Appropriate ranking in table will be determined after further field experience.*

European Corn Borer The stalk breakage problem in any year cannot be predicted but will depend on many factors including weather conditions, stalk rot, wind and borers.

The cream-colored female moth usually lays her eggs on the underside of corn leaves, beginning in early June in southwestern Ontario and somewhat later in other parts of the province. After hatching, the young borers feed on the leaves, giving them a pinpricked appearance. Sometimes the feeding scars are elongate. Later, the borers work downward into the "throat" (whorl) of the plant and feed on the developing leaves. Afterwards, they enter the stalk. Control is effective only if the borers are destroyed before they enter the stalk. It is most important to select a hybrid with good standability and thus some resistance to breakage. Avoid plant populations that are too high for the hybrid grown. Higher plant populations lower stalk quality and can result in more breakage. In addition, growers should plant as early as feasible to reduce the infestations by the second generation where it occurs, and to obtain as early a harvest as possible. Harvest as soon as suitable moisture levels are reached to decrease losses from dropped ears and broken stalks which occur during autumn storms.

European Corn Borer Strains There are two distinct strains of the European corn borer in Ontario. Most areas have the strain with a single generation per year, but south of a line from Sarnia to London and Simcoe, the strain has two generations per year. There is some resistance to leaf feeding by the single-generation strain and the first generation of the two-generation strain, but none by the second generation feeding where it occurs. The resistance ratings, as such, are not available but are reflected, among other factors, in the standability ratings available in the current Ontario Hybrid Corn Performance Trial Report.

Two-Generation Area In the southwestern area where the two-generation strain occurs, the second generation is larger than the first, is more abundant in late-planted corn, and is responsible for most of the ear loss due to damaged shanks and stalks. For this reason the non-chemical recommendations listed above are generally preferable. If insecticides are applied, use a material listed below but apply it in August against the second generation. Eggs for this generation are laid over a three-week period. Probably more than one application would be required for significant control.

One-Generation Area Where only one generation occurs, losses can be high enough to warrant control. You should examine the plants for borer feeding before tassels show in the whorl or when plants are about 60 cm tall. Examine the plants at 10-day intervals and spray if you find that more than 50% of the plants have feeding scars. Two applications, 7 to 10 days apart, may be needed for significant control. Once the larvae bore into the stalks, treatments are not effective and should not be applied. In some years the one generation strain produces a partial second generation. This flight is usually small and occurs towards the end of August. It does not pose a serious threat to corn. For further information, see OMAF Factsheet, *European Corn Borer*, Agdex 111/622.

Table 18. European Corn Borer Control

Insecticide	Product per ha
Cymbush 250 EC	280 mL
Ripcord 400 EC	175 mL
*Furadan 480 F	1.1 L
Bactospiene[1]	2.6 L for seed corn only

EC (Emulsifiable Concentrate); F (Flowable).

**Minimum period before reentry is 48 hours. See Reentry into Treated Areas.*

[1] *Bactospiene is a biological insecticide containing an insect toxin produced by the bacterium* Bacillus thuringiensis. *For effective control applications must be timed for newly hatched larvae. Delayed timing results in poor control. Good leaf coverage is essential to achieve effective control.*

Bees often visit sweet and field corn to collect pollen. Where spraying is being done bee poisoning may result. **Furadan** is **highly toxic to bees.** If bees are in the area, advise local keepers of spraying activity. Your local agricultural representative has a listing of beekeepers in your area. Damage to bees is reduced when sprays are applied in early morning or late evening when bees are not foraging. Do not treat when the wind is blowing. Avoid contamination of roadsides and adjacent fields where plants may be in bloom.

Cutworms They are found in the soil and attack seedling corn in the two-to-five-leaf stage. Plants suddenly wilt because the stem is hollowed out or cut off at or just below ground level. The cutworms can usually be found in the soil within a few centimetres of damaged plants. There are a number of species of cutworms and they may be gray to dark brown in color and striped or mottled. Mature cutworms are about 3.5 cm long. Cutworms that are nearly mature (over 2.5 cm long) are difficult to control but they will stop feeding in a few days when they reach full size. Insecticide application is not recommended in this case because most of the damage is done and it is better to wait a few days and replant. Treatment is most effective when applied soon after cutworms have hatched. Only a small acreage of Ontario corn has cutworm problems any one year. For this reason, and because corrective sprays are available, granular treatments applied at planting time are not recommended.

If seedling corn is attacked and the cutworms are small, apply one of the following treatments in 400 L of water per hectare at the seedling (2- to 5-leaf) stage when damage first appears. Cutworms are most active in the evening and treatments are best applied at this time.

Table 19. Cutworm Control[1]

Insecticide	Product per ha
Ambush 500 EC[2]	225-300 mL
Lorsban 4E	2.4 L
Ripcord 400 EC	175 mL

E or EC (Emulsifiable Concentrate)

[1] *Seedling stage only.*

[2] *Read the label. Do not disturb the soil for 5 days after application.*

Armyworm Because weed-infested corn is attractive to armyworm moths for egglaying, eliminate grasses and weeds from the corn crop. The result will be less armyworm damage to corn. (See Ontario Ministry of Agriculture and Food Publication 75, *Guide to Weed Control*). When armyworms move into corn fields, spray the border rows and adjacent cereals, pasture, or hay crops. Refer to Armyworms in Cereals section for more information.

Potato Stem Borer This pest of corn is more severe in the eastern counties but infestations occur throughout the province.

Seedling corn is destroyed by larvae (pinkish worms 4 cm long when mature) that bore into the base of plants just below or above ground level. The leaves of infested plants wilt and turn brown from the tips downward. Seedlings up to 40 cm high wither and die. Such plants break off at ground level when pulled. The worm may be found in the stalk or in the soil near the base of the plant. The larvae move to corn in late May or early June from grassy field borders.

At present there are no effective insecticides to control the potato stem borer in corn. To reduce infestations maintain weed-free fields. Quackgrass, along with other perennial grasses, acts as a primary weed host for the potato stem borer.

Corn Leaf Aphid These small dark aphids do not overwinter in Ontario. Each year they are carried into the province by air currents. Populations of 400 or more per plant, especially under dry conditions, may be economically important. See OMAF Factsheet, *Corn Leaf Aphid*, Agdex 111/622.

White Grubs The larvae of June beetles have plump, white bodies with large brown heads and six prominent legs. They are found in a "C"-shaped position in the soil near the roots of plants. The adults lay their eggs in sod and white grubs are therefore a problem in corn following sod, particularly in run-down fields or pastures. When such fields are plowed, the partly grown larvae can be found, especially if the sod is broken apart and examined carefully.

Sap Beetles They are small dark beetles about 6 mm long with two yellow spots on each wing cover. These beetles are often numerous in corn fields but do not cause significant damage.

Slugs are legless creatures (mollusks) that glide along on a path of mucus. This mucus dries out and can be seen in the daytime as a shiny trail over the leaves and soil. Slugs feed on the lower leaves of the corn, especially in the areas between the veins. This feeding often causes the leaves of corn to split lengthwise. If mucus trails or split leaves are seen, slugs can usually be found hiding during the day under stones, clods, and plant debris. The most troublesome slug in corn is the gray garden slug which is 1 to 2 cm long, gray, legless and slimy.

Damage to corn is most serious in May and June before the plants are well established. Treatments with a molluscicide are too expensive to be practical in field corn. Slugs are very dependent on moisture and organic matter on or near the soil surface. Slugs are most likely to be a problem on wet fields, following late spring plowing of red clover and with minimum tillage. See OMAF Factsheet, *Slugs*, Agdex 610.

Insects in Stored Grain

Stored Grain Insects — Surveys have shown that stored grain in county elevators and on farms in Ontario have the heaviest insect infestations of any region in Canada. For control measures, see section *Insects in Farm Stored Grain* under Cereal Crops, Insect Section.

WEED CONTROL IN CORN

For weed control recommendations see OMAF Publication 75, *Guide to Weed Control.*

BEFORE
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ANY PESTICIDE
STOP
READ THE LABEL
CAREFULLY

SOYBEANS

CROP MANAGEMENT

Soybeans should be planted from May 10 to May 25. Later planting will cause marked yield decreases.

When seeding, make allowance for variety seed-size differences. A seeding rate of 67 kg/ha (1 bu/ac) is adequate for all varieties in 36 to 71 cm rows. Eighteen centimetre rows are recommended under short growing season conditions. Adjust seeding rate upward for lower germination or for soils which crust badly. Uniform depth of seeding, 3 to 5 cm, is important.

Table 20. Seeding Rate

	Row Width (centimetres)			
	18	36	53	71
	Number of Seeds/Metre of Row[1]			
	10	15	21	29
Number of Seeds/Kilogram	**Seeding Rate[2] (kg/ha)**			
4000-5000 (Large Seeds)	154-123[3]	115-92	115-92	115-92
5000-6000	123-103	92-77	92-77	97-77
6000-7000	103-87	77-67	77-67	77-67
7000-8000 (Small Seeds)	87-78	67-58	67-58	67-58

[1] *18-cm row width calculations based on a stand of 500,000 plants per hectare. 36-cm and wider row width calculations based on a stand of 400,000 plants per hectare.*

[2] *Calculations are adjusted for 90% seed germination.*

[3] *kg/ha × .9 = lb/ac*

Inoculation

When soybeans are grown on land for the first time, inoculation with soybean rhizobia is essential for high yields. Under these conditions, soil-applied granular inoculants produce more consistent nodulation and higher yields than seed-applied powders. Therefore, granular inoculant is recommended on new soybean land, at rates from 5 kg/ha in wide rows up to 10 kg/ha in rows 18 cm apart.

Granular inoculant is applied through granular insecticide applicators on a corn planter, with delivery tubes brought forward to place the inoculant in the seed furrow. In a grain drill, the grass seed box can be used for granular inoculant with tubing added to drop the inoculant with the seed. With newer drills, the granular inoculant may be applied through the fertilizer hopper. After nodulated soybeans have been grown on a field, the use of granular inoculant is not recommended because it usually does not cause yield increases.

If soybeans have only been grown for one or two years, or if they have not yet been grown for several years, soybean seed should be inoculated with powdered peat inoculant to ensure nodulation. For growers using powdered inoculant, use of a sticker will ensure uniform adhesion to the seed. The seed treatment Anchor serves as a sticker as well as a fungicide.

As a remedial measure, if nodulation does not occur, apply 50 kg/ha of nitrogen after full flower.

VARIETY SELECTION

It is important to select a variety that corresponds to the heat unit rating for your farm (Figure 1). A variety that takes advantage of the full growing season will generally yield more than those maturing earlier.

If winter wheat is to be grown after soybeans using conventional tillage methods, select a variety that requires about 300 heat units less than the number available in your area. If winter wheat is to be broadcast into a standing crop, select full season varieties.

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre

Kilograms per hectare x 0.4 = kilograms per acre.

BEFORE
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CAREFULLY

Table 21. Soybean Variety Recommendations and Description

Variety	Heat Units Required	Colour	Seeds per Kilogram	Phytophthora Root Rot Reaction % Plant Loss[1]	Distributor
Maple Ridge[2]	2400	yellow	6370	8	SeCan members
Baron[2]	2450	dark brown	5590	6	W.G. Thompson & Sons Ltd.
Maple Amber[2]	2450	brown	6100	13	Public variety
Maple Isle	2500	yellow	5560	15	Public variety
Apache[2]	2600	gray	5780	9	W.G. Thompson & Sons Ltd.
Bicentennial	2600	brown	5100	5	SeCan members
KG 30	2600	dark brown	7250	19	Pride Brand Seeds
KG 40	2600	yellow	6450	7	King Agro
Maple Arrow*	2600	brown	5680	9	Public variety
Maple Glen	2600	yellow	5240	21	SeCan members
OAC Scorpio	2600	yellow	5750	35	SeCan members
9061	2650	yellow	7410	31	Pioneer Hi-Bred Ltd.
OAC Libra	2650	black	6620	7	SeCan members
0877	2700	light gray	6170	20	Pioneer Hi-Bred Ltd.
J081	2700	yellow	5780	21	Jacques Seed Co.
KG 60*	2700	buff	5790	5	King Agro
Evans	2750	yellow	6370	20	Public variety
Maple Donovan*	2750	buff	7140	13	SeCan Members
Marathon	2750	yellow	5360	14	W.G. Thompson & Sons Ltd.
OAC Aries	2750	dark brown	6150	18	SeCan members
OAC Musca	2750	tan	5860	11	SeCan members
PS 61	2750	yellow	5800	7	Pride Brand Seeds
Commander*	2850	yellow	5100	12	W.G. Thompson & Sons Ltd.
Crusader	2850	yellow	6190	22	W.G. Thompson & Sons Ltd.
OAC Dorado[3]	2850	brown	5990	20	SeCan members
PS 72	2850	yellow	6610	14	Pride Brand Seeds
S09-70	2850	yellow	6500	9	Northrup King Seeds Ltd.
1282	2900	buff	5300	15	Pioneer Hi-Bred Ltd.
A0949	2900	yellow	5800	12	Cargill Grain Co. Ltd.
A1564	2900	yellow	5700	16	Cargill Grain Co. Ltd.
A1895	2900	black	6060	8	Cargill Grain Co. Ltd.
B152*	2900	yellow	5780	9	Northrup King Seeds Ltd.
Galaxy	2900	buff	5650	7	W.G. Thompson & Sons Ltd.
Haroson*	2900	buff	6220	7	SeCan members
Hodgson	2900	buff	5980	17	Public variety
KG 82	2900	tan	5500	7	King Agro
PS 80	2900	yellow	6500	12	Pride Brand Seeds
S1346	2900	yellow	5750	10	Northrup King Seeds Ltd.
S15-50*	2900	gray	6940	4	Northrup King Seeds Ltd.
T8508	2900	black	5440	5	W.G. Thompson & Sons Ltd.
A1937	2950	buff	6100	11	Cargill Grain Co. Ltd.
1677	3000	yellow	7000	29	Pioneer Hi-Bred Ltd.
A2234	3000	black	5830	3	Cargill Grain Co. Ltd.
RCAT Alliance*[3]	3000	black	5780	7	SeCan members
Hawk	3000	black	6130	10	W.G. Thompson & Sons Ltd.
A2187	3025	yellow	6490	10	Cargill Grain Co. Ltd.
9202	3050	yellow	5560	6	Pioneer Hi-Bred Ltd.
CX226	3050	buff	6200	12	DeKalb Canada Ltd.
B220	3075	yellow	6460	23	King Agro
Elgin	3075	black	6090	14	Public Variety
KG 92	3075	yellow	5770	8	King Agro
Premier	3075	yellow	6480	9	Pride Brand Seeds
CX174	3100	buff	5580	19	DeKalb Canada Ltd.
Elgin 87**[3]	3100	black	6000	6	SeCan members

(Continued on Page 22)

Table 21. Soybean Variety Recommendations and Description (Cont.)

Variety	Heat Units Required	Colour	Seeds per Kilogram	Phytophthora Root Rot Reaction % Plant Loss[1]	Distributor
Jewel	3100	yellow	6310	33	W.G. Thompson & Sons Ltd.
UCO 112	3100	brown-black	5600	8	United Co-op of Ontario
S24-24*	3150	yellow	6640	11	Northrup King Seeds Ltd.
9271	3150	brown	5520	13	Pioneer Hi-Bred Ltd.
Corsoy 79*	3150	yellow	6540	10	Public variety
PS 90	3150	yellow	6320	15	Pride Brand Seeds
9292	3175	brown	5580	12	Pioneer Hi-Bred Ltd.
A2630	3175	brown-black	7170	7	Cargill Grain Co. Ltd.
Combat	3175	yellow	6300	6	W.G. Thompson & Sons Ltd.
J103	3175	yellow	5930	27	Jacques Seed Co.
J231	3175	brown-black	4980	20	Jacques Seed Co.
S26-06	3175	buff	5380	9	Northrup King Seeds Ltd.
KG 100	3225	black	6600	14	King Agro
Birch	3300	yellow	6560	14	Ferguson Seed
A2943	3325	brown-black	6260	12	Cargill Grain Co. Ltd.
A3127	3350	black	6960	9	Cargill Grain Co. Ltd.

**Varieties with resistance to most races of the Phytophthora root rot organism in Ontario.*

***Varieties with resistance to all races of Phytophthora root rot organism in Ontario.*

[1] *Three year average (1986-88) in a field heavily infested with Phytophthora. Not all race of Phytophthora root rot are found at this site. Thus the relative ranking of varieties of plant loss may differ in fields that have other races present.*

[2] *Metribuzin herbicide should not be used on Maple Ridge, Baron, Maple Amber or Apache.*

[3] *Seed supplies of these varieties will be limited in 1989.*

Table 22. Agronomic Data — 2400-2900 Heat Unit Areas

Testing Areas	Variety	Heat Unit Rating	Yield (t/ha)	Yield Index %	Days from Planting to Maturity	Plant Height (cm)	Lodging 1 = standing 5 = flat
3 year average of 9 trials at Brussels, Elora, Winchester and Ottawa	Maple Ridge	2400	2.79	96	107	82	1.7
	Baron	2450	2.81	96	107	88	2.6
	Maple Amber	2450	2.63	90	110	90	2.4
	Maple Isle	2500	2.71	93	111	81	1.8
	Maple Arrow	2600	2.81	96	117	96	2.7
	KG 30	2600	2.91	100	117	97	2.5
	Maple Glen	2600	3.19	110	118	89	1.9
	KG 40	2600	2.90	100	119	83	1.8
	Bicentennial	2600	2.91	100	119	99	3.0
	Apache	2600	2.96	101	121	91	2.1
	OAC Scorpio	2600	3.02	104	122	100	2.8
	OAC Libra	2650	2.95	101	124	105	3.5
	9061	2650	3.07	105	123	94	2.2
	Maple Donovan	2750	3.02	104	125	100	2.7
	Evans	2750	2.86	98	127	110	3.3
	0877	2750	2.99	103	127	113	3.3
	Average yield		2.91				

(Continued on Page 23)

Table 22. Agronomic Data — 2400-2900 Heat Unit Areas (Cont.)

Testing Areas	Variety	Heat Unit Rating	Yield (t/ha)	Yield Index %	Days from Planting to Maturity	Plant Height (cm)	Lodging 1 = standing 5 = flat
3 Year Average of 9 trials at Centralia, Woodstock, Talbotville and Smithfield	Maple Arrow	2600	2.55	91	110	74	1.6
	Apache	2600	2.72	97	110	70	1.3
	Bicentennial	2600	2.81	100	112	77	1.6
	OAC Libra	2650	2.83	101	116	79	1.8
	0877	2700	2.88	103	116	82	1.8
	J081[3]	2700	2.77	99	116	80	1.4
	Maple Donovan	2750	2.87	103	118	81	1.6
	KG 60	2700	2.89	103	119	70	1.7
	Evans	2750	2.77	99	120	86	1.8
	OAC Aries	2750	2.71	97	121	93	2.4
	Marathon	2750	2.78	99	121	84	1.9
	OAC Musca	2750	2.75	98	121	90	2.3
	PS 61	2750	2.88	103	123	82	1.3
	Crusader	2850	2.81	100	121	86	1.7
	S09-70	2850	2.76	99	122	82	1.6
	Commander	2850	2.79	100	122	90	2.1
	OAC Dorado	2850	2.99	107	123	82	1.4
	Haroson	2900	2.87	103	123	86	1.8
	Hodgson	2900	2.91	104	124	90	1.7
	A0949	2900	2.81	100	124	90	1.8
	PS 72	2900	2.67	95	124	78	1.7
	1282	2900	2.94	105	125	95	1.9
	S15-50	2900	2.86	102	126	88	1.5
	S1346	2900	2.88	103	127	76	1.4
	A1564	2900	2.78	99	127	94	1.8
	Galaxy	2900	2.70	96	127	91	1.7
	KG 82	2900	2.84	101	128	90	1.6
	Average yield (t/ha)		2.80				

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[1] *1 t/ha = 1 tonne/hectare = 15 bu/ac*

[2] *For each test, Yield Index is expressed as a percentage of the average yield of all recommended varieties grown in that test area.*

[3] *J081 was not tested in 1986. Values for 1986 were calculated from results in 1985, 1987 and 1988 using common check varieties.*

Table 23. Agronomic Data — 2900-3350 Heat Unit Areas

	Variety	Heat Unit Rating	Yield Index[1] %	Plant Height (cm)	Lodging 1 = standing 5 = flat
Heavier Soils — 3 year Average of 6 trials at Inwood (Clay) and and Fingal (Silt Loam)	Crusader	2850	95	78	2.0
	1282	2900	93	82	1.8
	Haroson	2900	99	78	1.7
	Hodgson	2900	95	80	1.8
	A1564	2900	98	87	2.0
	PS 80	2900	98	88	1.6
	S15-50	2900	101	85	1.4
	B152	2900	100	68	1.1
	S1346	2900	99	71	1.1
	T8508	2900	107	76	1.3
	A1895	2900	101	75	1.6
	A1937	2950	101	86	2.0
	RCAT Alliance	3000	103	91	1.1
	1677	3000	96	76	1.8
	Hawk	3000	94	76	2.8
	9202	3050	106	76	1.1
	Premier	3075	99	81	1.9

(Continued on Page 24)

Table 23. Agronomic Data — 2900-3350 Heat Unit Areas (Cont.)

	Variety	Heat Unit Rating	Yield Index[1] %	Plant Height (cm)	Lodging 1 = standing 5 = flat
	Elgin	3075	105	79	2.0
	Elgin 87	3075	104	81	2.6
	B220	3075	99	87	1.5
	CX174	3100	102	83	1.5
	Jewel	3100	105	79	1.9
	S24-24	3125	101	88	2.6
	9271	3150	106	79	1.3
	Corsoy 79	3150	99	92	2.5
	Average yield (t/ha)	3.60			
Lighter Soils — 3 year Average of 6 trials at R.C.A.T. (Clay loam) and Talbotville (Clay loam)	Crusader	2850	98	88	2.0
	1282	2900	95	96	2.2
	Haroson	2900	100	85	1.9
	Hodgson	2900	97	89	1.7
	A1564	2900	97	96	2.1
	PS 80	2900	96	96	2.0
	S15-50	2900	99	91	1.7
	B152	2900	101	80	1.5
	S1346	2900	105	86	1.6
	T8508	2900	106	88	1.6
	A1895	2900	98	78	1.9
	A1937	2950	102	95	2.1
	RCAT Alliance	3000	100	95	1.4
	1677	3000	97	86	2.0
	Hawk	3000	94	84	2.8
	9202	3050	108	84	1.7
	Premier	3075	94	85	1.9
	Elgin	3075	103	86	2.0
	Elgin 87	3075	102	84	2.3
	B220	3075	97	91	1.9
	CX 174	3100	99	90	1.9
	Jewel	3100	108	88	2.0
	S24-24	3125	103	94	2.3
	9271	3150	104	84	1.5
	Corsoy 79	3150	96	106	2.4
	Average yield (t/ha)	3.70			
Heavier Soils — 3 year average of 4 trials at Woodslee (Clay) and Tilbury (Clay)	Hodgson	2900	101	72	1.4
	Haroson	2900	100	72	1.3
	B152	2925	87	58	1.1
	S15-50	2950	97	75	1.1
	A1895	2950	98	65	1.1
	A1937	2950	100	74	1.2
	Hawk	2950	96	66	1.3
	S1346	2950	84	53	1.0
	1677	2950	88	64	1.1
	A2234	3000	107	67	1.0
	9202	3000	100	62	1.0
	A2187	3025	93	71	1.1
	UCO112	3025	100	71	1.2
	CX226	3050	100	65	1.2
	Premier	3050	100	70	1.3
	B220	3075	87	66	1.1
	Elgin	3075	102	71	1.3
	Jewel	3075	103	63	1.2
	KG 92	3075	105	65	1.1

(Continued on Page 25)

Table 23. Agronomic Data — 2900-3350 Heat Unit Areas (Cont.)

	Variety	Heat Unit Rating	Yield Index[1] %	Plant Height (cm)	Lodging 1 = standing 5 = flat
	CX174	3100	107	70	1.2
	Elgin 87	3100	107	73	1.5
	PS 90	3100	92	77	1.3
	S24-24	3100	106	78	1.5
	9271	3100	104	65	1.1
	J231	3125	98	70	1.3
	Corsoy 79	3150	104	82	2.0
	Combat	3150	104	81	1.5
	J103	3150	96	68	1.3
	A2630	3175	108	72	1.0
	S26-06	3175	108	71	1.0
	9292	3175	109	68	1.2
	KG 100	3225	103	79	1.1
	Birch	3300	104	90	2.0
	A2943	3325	105	81	1.1
	A3127	3350	101	79	1.4
	Average yield (t/ha)	3.28			
Lighter Soils — 3 year average of 5 trials at Malden (Clay loam) and Chatham (Clay loam)	Hodgson	2900	101	96	3.0
	Haroson	2900	98	98	2.6
	B152	2925	100	90	1.8
	S15-50	2950	101	106	2.3
	A1895	2950	95	86	2.6
	A1937	2950	106	105	2.9
	Hawk	2950	90	92	4.2
	S1346	2950	101	93	1.7
	1677	2950	94	96	3.0
	A2234	3000	98	94	2.0
	9202	3000	107	94	2.3
	A2187	3025	100	108	2.4
	UCO112	3025	101	108	2.4
	CX226	3050	96	91	2.9
	Premier	3050	97	105	3.1
	B220	3075	99	110	2.3
	Elgin	3075	100	93	3.2
	Jewel	3075	106	104	2.9
	KG 92	3075	102	97	2.6
	CX174	3100	97	98	2.8
	Elgin 87	3100	99	96	3.3
	PS 90	3100	97	116	3.0
	S24-24	3100	99	107	3.5
	9271	3100	100	92	2.1
	J231	3125	104	103	2.4
	Corsoy 79	3150	98	122	3.4
	Combat	3150	99	120	3.2
	J103	3150	101	101	2.9
	A2630	3175	102	96	1.8
	S26-06	3175	108	94	2.4
	9292	3175	104	94	2.2
	KG 100	3225	102	105	2.8
	Birch	3300	96	123	3.9
	A2943	3325	105	113	2.5
	A3127	3350	101	102	2.8
	Average yield (t/ha)	3.91			

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[1] *For each test Yield Index is expressed as a percentage of the average yield of all recommended varieties grown in that test area.*

FERTILIZERS FOR SOYBEANS

Nitrogen

Nitrogen fertilizers are not usually required for soybeans, but where phosphorus fertilizers are banded, a small amount of nitrogen (10 kg/ha) may improve the availability of the phosphate. Also, see *Inoculation* in the *Soybean Crop Management* section.

Phosphate and Potash

Phosphate and potash requirements for soybeans are given in Table 24. For information on use of this table see *Fertilizer Recommendations* in *Soils* section.

Table 24. Phosphate and Potash Requirements for Soybeans Based on OMAF Soil Tests

Sodium Bicarbonate Phosphorus Soil Test (ppm)	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Ammonium Acetate Potassium Soil Test (ppm)	Rating	Potash (K_2O)[1] Required kg/ha
0- 3		80	0- 15		120
4- 5		60	16- 30		110
6- 7	LOW	50	31- 45	LOW	90
8- 9		40	46- 60		80
10-12		30	61- 80		60
13-15	MEDIUM	20	81-100	MEDIUM	40
16-30	HIGH	0	101-120		30
31-60	VERY HIGH	0	121-150	HIGH	0
61+	EXCESSIVE[2]	0	151-250	VERY HIGH	0
			251+	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac

[1] *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure Section in Soils). Example of fertilizer application: If a soybean crop is not manured and the soil tests are 9 for phosphorus and 85 for potassium, the phosphate requirement is 40 kg/ha and the potash requirement 40 kg/ha (see above table). Ten kilograms of nitrogen are also recommended. These nutrients can be supplied by broadcasting or banding 170 kg/ha 6-24-24 fertilizer.*

[2] *For a nutrient which has an excessive rating by soil analysis, the application of this nutrient in fertilizer or manure may cause problems due to reduced crop yield or quality. Phosphorus additions may also increase the risk of water pollution. Potash additions may induce magnesium deficiency on soils low in magnesium.*

Plant Analysis

For soybeans, sampling the top fully developed leaf (3 leaflets plus stem) at first flowering is recommended. However plants suspected of having a nutrient deficiency should be sampled as soon as the problem appears. Expert help will be required to interpret plant analysis results if the samples are not taken at flowering.

For more information on plant analysis see *Plant Analysis* section in *Soils*.

Micronutrients

Manganese is the only micronutrient deficiency diagnosed in soybeans in Ontario although zinc deficiency may show up in the future where the surface soil has been lost by erosion.

With manganese deficiency, the upper leaves range from pale green (slight deficiency) to almost white (severe deficiency) while the veins remain green. In addition to deficiency symptoms both soil tests and plant analyses are useful in predicting where manganese deficiencies are likely to occur. Both are available at the OMAF soil testing and plant analysis laboratory.

Correct the deficiency as soon as detected by spraying the foliage with 2 kg of manganese/ha from manganese sulfate (8 kg of manganese sulfate/ha) in 200 L of water.

A "spreader-sticker" in the spray is recommended for materials other than chelates. If the deficiency is severe, a second spray may be beneficial.

Table 25. Interpretation of Plant Analysis for Soybeans[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen (N)	%	4.0	6.0
Phosphorus (P)	%	0.15	0.50
Potassium (K)	%	1.2	2.5
Calcium (Ca)	%	—	3.0
Magnesium (Mg)	%	0.10	1.00
Boron (B)	ppm	20	55
Copper (Cu)	ppm	4	30
Manganese (Mn)	ppm	14	100
Molybdenum (Mo)	ppm	.5	5.0
Zinc (Zn)	ppm	12	80

[1] *Values apply to the top fully developed leaf (3 leaflets plus stem) at first flowering.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Never use spray equipment which has been used for spraying hormone-type herbicides such as 2,4-D. Beans are very sensitive to this type of herbicide.

Soil application is not a recommended way to apply manganese regardless of the source because of the large amounts required. Application of manganese chelates to the soil has resulted in yield reductions.

For further details on manganese deficiency and on methods of application refer to OMAF Factsheet, *Manganese in Soybeans and Small Grain Production*, Agdex 100/531.

Methods of Application

Fertilizer should not be placed in contact with soybean seeds. The fertilizer may be broadcast and plowed down or worked into the soil either in the fall or spring; or a planter with a separate attachment for fertilizer placement may be used to place the fertilizer 5 cm to the side and 5 cm below the seed. For further information see Table 12. *Maximum Safe Rates of Nutrients* in the *Soils* section.

DISEASE AND INSECT CONTROL IN SOYBEANS

(see also Pesticides section)

Seed Treatments

Follow the precautions under *Seed Treatments* in *General Information in Pesticide Usage* section, when applying any chemical seed treatment.

Seed treatments are recommended for control of seed decay, damping-off, and seedling blight which are caused by various seed-borne and soil-borne fungi. These diseases reduce germination, plant stand and yield.

Seed treatments are recommended also for control of seed maggots and wireworms in areas where these insects are a problem. Seed maggots usually are damaging on lighter soils high in organic matter. Wireworms may be a problem in soybeans that follow sod or pasture. The recommended insecticides are Diazinon and Lindane, but they can cause seedling injury when one or both are used. The addition of a fungicide such as captan makes these products safer on soybeans seed and in addition controls seed decay and seedling diseases.

Table 26. Soybean Seed Treatments

Product	Active Ingredients	Formulation[1]	Diseases Controlled		
			Phomopsis Seed Mold	**Rhizoctonia Damping Off**	**Other Seed Decay and Seedling Blight[2]**
Insect and Disease Control					
Bin-run (Untreated) Seed					
Agrox B-3	diazinon + lindane + captan	P (DB)	—	—	+
Seed Pretreated with Fungicide					
Agrox D-L Plus	diazinon + lindane + captan	P (DB)	—	—	+[3]
Co-op D-L+C	diazinon + lindane + captan	P (DB)	—	—	+[3]
Drillbox D-L+C	diazinon + lindane + captan	P (DB)	—	—	+[3]
Disease Control					
Anchor	carbathiin + thiram	F (DB)	+	+	+
Captan Flowable	captan	F	—	—	+
Vitaflo-280	carbathiin + thiram	F	+	+	+
Vitavax Powder	carbathiin + thiram	P (DB)	+	+	+

[1] *P (Powder); F (Flowable); DB (Drill Box Application).*

[2] *Caused by other soil fungi especially pythium.*

[3] *Effective only when applied to seed already treated with captan.*

+Recommended for disease listed.

—NOT recommended

Among the products containing Diazinon, Lindane and captan, only Agrox B-3 contains sufficient captan fungicide to be used on untreated soybean seed. Agrox D-L Plus, Co-op D-L+C and Drillbox D-L+C contain about half as much captan as needed, and therefore should only be used on seed previously treated with Anchor, captan, Vitaflo-280 or Vitavax powder. In areas where insect problems are minimal, use seed treatments containing fungicide only, such as captan, Anchor, Vitaflo-280 or Vitavax powder.

Phytophthora Root Rot is a potential problem in heavy clay soils in southwestern Ontario. The disease has also been observed in central and eastern Ontario. Seedlings may be killed prior to emergence or plants may be killed any time before maturity. A reddish discolouration extending from the roots to the lower nodes is evident on the stems of wilted plants. Dead plants may occur as either a few in a row or as patches in low areas of fields. Control of Phytophthora root rot requires a combination of soybean variety selection and good soil management.

Soybean varieties with resistance or tolerance to Phytophthora root rot are available. Some varieties have both resistance and tolerance. Consult the current *Report, Ontario Soybean Variety Trials,* available from your county OMAF office, for variety ratings for Phytophthora root rot.

1. Resistant varieties. The Phytophthora fungus is present in Ontario soils as a series of races (or "strains"). Resistance in any one soybean variety is effective against some but not all of the races. Root rot is controlled in a particular field when the variety grown is resitant to all of the Phytophthora races that happen to be present in that field. Resistance will "break down", however, should another race appear to which the variety is not resistant. If this occurs, use a tolerant variety.
2. Tolerant varieties. Some disease develops in these varieties when grown in infested soils, regardless of which races of Phytophthora are present. However yields of tolerant varieties usually are not seriously reduced by the disease.

Any soil management practice which reduces soil compaction or waterlogging will decrease the incidence of Phytophthora root rot. On clay soils where the disease may be a problem, the following procedures are recommended.

a. Choose a variety with a low percentage of infected plants.

b. Prepare seedbeds by fall plowing and spring tillage.

c. Do not plow or disk when the soil is wet.

d. Plow in crop residues or manure to improve soil structure.

e. Include crops in a rotation which improve soil structure.

f. Inspect each soybean field for dead plants in late July or early August to determine whether or not the variety has enough resistance/tolerance to provide adequate protection under local conditions.

Rhizoctonia Root Rot has been found in most of the soybean growing areas of southwestern Ontario. Symptoms of the disease are very similar to plants infected with Phytophthora, except reddish lesions produced on roots and lower stems seldom extend above the soil line. There are no commercial varieties that are tolerant to Rhizoctonia.

DISEASES

Phomopsis seed mold (Pod and Stem Blight) develops near harvest when weather is warm and wet. Fine cracks usually develop in the coat of the infected seed, especially near the hilum. A white or grey mold may be visible on the seed surface. The yield, grade, viability and vigour of the seed can be reduced. Whenever possible, grow full-season varieties that mature during the cool weather late in the growing season. Varieties that are short-season for an area tend to mature earlier when conditions are warmer and more favorable for seed mold. Seed treatment (Table 26) usually increases germination and emergence of seed. However distorted seed with visible fungal growth often fails to germinate, even when treated. Rotating soybeans with other crops and plowing under crop residues help to reduce disease severity.

Powdery Mildew develops on the leaves usually in August and September. White powdery growth of the mildew fungus appears on the upper surface of the leaf. The seeds do not become infected. Yield losses usually occur only when outbreaks of powdery mildew begin early, in July, and remain severe until maturity. Cool cloudy weather favors the disease.

Downy Mildew appears as yellow, and later, brown spots on the leaves during August and September. In moist weather a pale blue to gray, downy growth of the mildew fungus appears on spots on the lower leaf surface. Severely affected leaves may drop prematurely. Whitish growth of the fungus may encrust the seeds, even within pods that appear healthy. Varieties differ in susceptibility; the variety **Evans** is highly susceptible, but **Maple Arrow** has considerable resistance. Rotate soybeans with other crops and plow under crop refuse.

White Mold may cause damage to soybean under cool, wet conditions. Stems, pods and leaves infected with white mold are pale brown and water-soaked in appearance. Frequently a white cotton-like growth and small dark bodies (sclerotia) can be seen on or within stems of diseased plants. The sclerotia survive many years in soil. In summer, disease arises from airborne spores produced on the sclerotia. Crop rotation may be useful for disease control in areas where white mold is uncommon. White mold is more likely to occur in soybeans following any bean, sunflower or canola crop in which white mold was present in previous years. Avoid this crop sequence if possible. In areas where white mold is common, however, the disease may appear in spite of crop rotation because of windblown spores from other fields. Some differences in disease severity in varieties have been noted. No resistant varieties have been identified but field observations indicate that early varieties in a geographic area are less prone to an epidemic than later varieties. Similarly, varieties with greater lodging resistance tend to be more resistant to white mold. For soybean fields with a history of severe white mold infection, producers should consider planting varieties which require 200-300 fewer heat units than normally available and which possess superior resistance to lodging.

INSECTS AND MITES

Insects Insect damage is seldom enough to cause soybean yield losses in Ontario. Green cloverworms may be prevalent in some years. Control measures for green cloverworms and grasshoppers are listed in Tables 74 and 75 in the *Field Bean* section. Follow precautions for handling chemicals. See *Pesticides* section.

Mites These are occasional pests of soybeans. The adults are tiny, rounded, eight-legged and are yellowish brown in colour. Both the adults and the immature feed on plant juices from the underside of leaves. Their feeding causes yellowing, curling and bronzing of the leaves. A close examination will show fine webbing on the lower surfaces of the foliage.

Mites are often found in soybeans about the time corn is silking. They usually move in from fence and hedge rows, especially in periods of drought as the weeds dry down. Mites also move into soybean fields as grain and other crops mature. There are many generations a year. Four or more mites per leaf or one severely damaged leaf per plant prior to pod-fill causes concern as crop yields are affected. Heavy rainfall reduces mite populations in soybeans.

WEED CONTROL IN SOYBEANS

For weed control recommendations see OMAF Publication 75, *Guide to Weed Control.*

FORAGE CROPS

Forages used as hay or improved pasture occupy 1.7 million hectares or approximately 37% of the improved land in Ontario. In addition to providing an economical source of ruminant nutriton, forages are also a valuable tool in sound soil management.

CROP MANAGEMENT

Species Selection

Species and Mixtures Forage species are divided into two groups – legumes and grasses. Legumes have short, broad, rounded leaves and when inoculated with the correct rhizobium bacteria, are able to meet much of their nitrogen needs by nitrogen fixation from the air. Grasses have long, slender leaves and do not fix nitrogen. Legumes in Ontario include alfalfa, bird's-foot trefoil, red and white clovers. Grasses include timothy, bromegrass and orchardgrass. Legumes are valued in rotation because of their tendency to enrich the soil in nitrogen. The fine fibrous root system of grasses has a beneficial effect on soil structure and tilth.

Forages are seldom grown in pure stands. They are typically seeded in mixtures of two or more species, selected to meet specific needs. Properly managed mixtures are more productive, more persistent and less prone to weed invasion than either grass or legumes grown alone. Factors which should be considered when selecting a mixture include: (a) the intended use of the stand, whether for hay, pasture or erosion control; (b) soil conditions likely to affect the stand, such as pH, drainage, or compaction; (c) the expected lifespan of the stand, and (d) the relative maturities of the components of the mixture. Refer to the individual species tables (Tables 28 to 37) to match the maturities of selected species. Refer to the species characteristic information and Figures 2 and 3 for detailed information on each species you are considering for a mixture. Recommended mixtures for stored feeds, pasture and intensive pasture are shown in Table 39.

In bird's-foot trefoil, timothy and orchardgrass, there is substantial variation in maturity among varieties. Use this variation to advantage when designing mixtures for specific uses. In a pasture mix, select varieties with similar maturities to help promote uniform grazing. Use of different maturities will encourage overgrazing of the "younger", later maturing species and allow the "older", earlier maturing species to be undergrazed. An early maturing variety will also be harder to keep ahead of in spring, while a later maturing variety will tend to remain vegetative longer. In a hay mixture, matching species and varieties of similar maturities can result in highest overall quality.

Soil and Fertility Factors Forage species differ in their sensitivity to soil and fertility factors. Species such as alfalfa require adequate drainage and soil pH above 6.0. The other legumes are less demanding, while grasses are generally most tolerant of adverse soil conditions. Legumes are especially responsive to phosphate

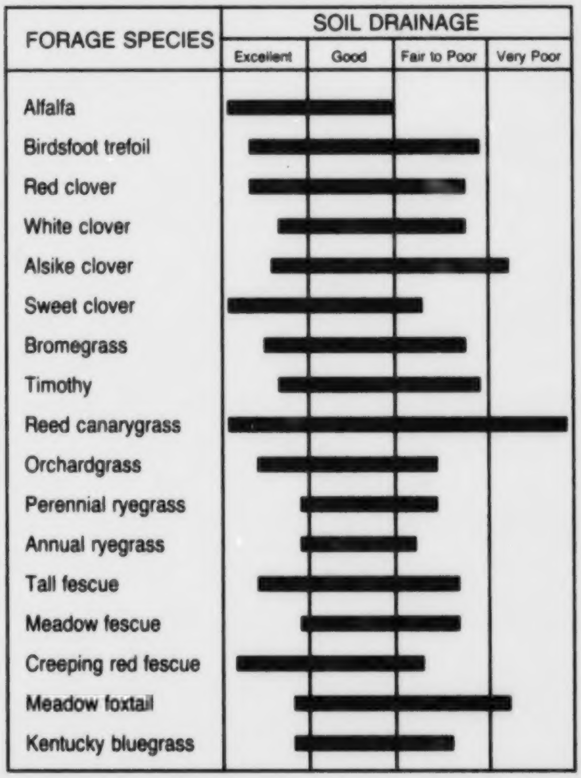

Figure 2. Soil Drainage Requirements of Forage Species

and potash fertility. Grasses grown alone also require nitrogen for high yields. For more information, see Factsheets, *Fertilizer Use in Forage Establishment* (Agdex 120/30), and *Fertilizer Practices for Alfalfa Production* (Agdex 121/542).

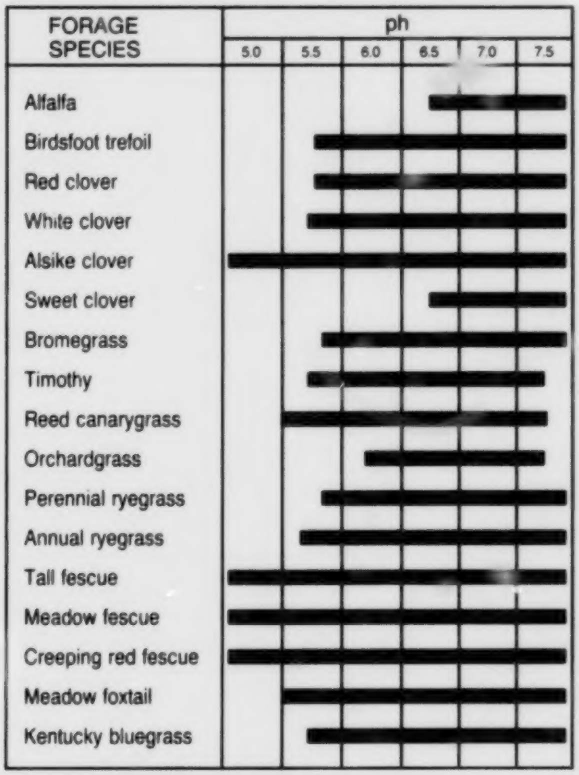

Figure 3. pH Requirements of Forage Species

Establishment

Seed Quality Quality seed is particularly important when establishing a perennial crop. Sow certified #1 seed to be sure of variety, germination standard and reasonable freedom from weed seeds.

Legume Inoculation Legume seed should be inoculated with rhizobium bacteria before sowing. Seed coated in the current season is a good method of inoculation. Each legume species requires its own specific strain of rhizobium for proper nodulation. If the legume being planted has never been grown on the field before, proper inoculation is vital to a successful stand. Since inoculant must be alive, note the expiry date and handling precautions on the packet to ensure effective nitrogen fixation.

Time of Seeding Chance of successful establishment is highest with early spring seedings. Summer seeding, not later than mid-August, can succeed if moisture is adequate for germination. Legumes seeded in September or October rarely survive the winter. September seeding of grasses may be successful.

Seeding Rates The amount of seed recommended in Table 39 is intended for average to good conditions. When seeding early on a fine firm seedbed, particularly if band seeding, these rates may be reduced by 25%. When coated seed is used, do not reduce these rates because coated seed contains fewer seeds per unit weight.

Table 27. Seeds Per Unit of Various Forage Species

Crop	Seeds per kg
Alfalfa	440,000
Red Clover	605,000
White Clover	1,760,000
Bird's-foot Trefoil	935,000
Sweet Clover	572,000
Alsike	1,540,000
Timothy	2,706,000
Orchard Grass	1,439,000
Bromegrass	300,000
Meadow & Tall Fescue	506,000
Perennial Rye Grass	500,000
Reed Canary Grass	1,173,000
Bluegrass	4,790,000

Depth of Seeding Forage establishment requires careful attention to seedbed preparation, because forage seeds are very small. As a rule of thumb, seeds should be placed at a depth of about 1 cm. Percentage emergence declines rapidly if forage seeds are planted more than 2 cm deep. For methods to improve establishment, see Factsheets *Successful Forage Establishment*, Agdex 120/22 and *Establishment of Bird's-foot Trefoil*, Agdex 122/22.

Companion Crop vs. Direct Seeding For many seedings, especially those involving shade tolerant legumes such as alfalfa and red clover, establishment can be successful with either a companion crop or a direct seeding. If straw or grain are required, or if annual grass weeds are a problem, or if the site is erosion-prone, then sowing with a companion crop may be desirable. Companion crops differ in their aggressiveness, with oats being least competitive and winter wheat being most competitive. For most forages, oats seeded at no more than 60 kg/ha is the best choice. At higher grain seeding rates or when lodging is a problem, the companion crop should be harvested early, either at the milk stage for silage or when knee-high by grazing. Because the companion crop competes with the establishing forage crop for light, a direct seeding is preferred for shade intolerant species, such as bird's-foot trefoil. Weed control, with herbicides or clipping, is usually essential for successful direct seedings. For weed control recommendations, see OMAF Publication 75, *Guide to Weed Control.*

Management for Stored Feed

Optimum harvest dates for forages are a compromise between needs for yield, quality and persistence. As the crop matures, dry matter yields and persistence increase but digestibility and % protein decrease. The general recommendation is to harvest at bud to 1/10 bloom for legumes and at boot to heads emerging stage for grasses. In the more southerly regions of Ontario, 2 to 3 harvests may be expected each year, while in the more northerly region, only 1 or 2 harvests may be feasible.

Forage quality is a measure of the value of the forage to the animal. Quality is determined by two major factors: (1) the forage nutrient value, consisting of energy, protein, vitamins and minerals. (2) the amount the animal will consume (voluntary intake) and the digestibility of the forage consumed.

Nutrients measured in forages are the energy, protein, and minerals. Energy is expressed as per cent TDN – Total Digestible Nutrients or as per cent DDM – Digestible Dry Matter. The ADF – Acid Detergent Fibre – test is often used to measure the forage energy level, because it is closely related to forage digestibility. As the plant matures, the fibre content (the undigestible portion of the plant) increases which lowers the per cent digestibility of the forage. Protein levels are highest in young plants and decrease as the plant matures. Energy and protein levels differ among forage species but the major factor affecting forage quality is the stage of growth of the forage at cutting or grazing. Maximum nutrients are obtained when the forage is cut at the early bud stage for legumes or the early heading stage for grasses. As plants mature not only do protein and energy drop but intake is decreased also.

Low soil fertility will lower the mineral content of the forage or cause growth deficiencies. Drought can cause high fibre levels in relatively young forage. But neither of these factors will affect quality as much as cutting date.

A highly digestible forage has nutrients in a form that are easily used by the animal. The forage is quickly broken down and passed from the rumen. This rapid passage through the rumen allows the animal to eat more forage. This higher intake allows the animal to take in more nutrients to grow faster or produce more milk.

A further benefit of harvesting early at maximum nutrient level is that there is more time for regrowth for additional harvesting or grazing.

Dry Hay Fresh grass and legume forages are conserved in various forms for storage and feeding during the winter months. With good management, drying long hay down to 16 to 18% moisture, either in the field or with artificial barn drying, can save most of the yield and quality of the standing forage. See Factsheet *Barn Hay Drying,* Agdex 120/736.

Field losses, including those caused by mowing, respiration, conditioning, raking and baling, reduce yield by at least 20%, even in the absence of rainfall. Mowing losses are greater with a flail-type than with a cutter-bar or rotary mower. Prolonged field drying increases respiration losses (up to 4% of total yield per day) and exposes hay to weathering and rainfall losses. Rainfall is most damaging to digestibility and palatability as well as to yield when it falls late in the drying cycle. Mechanical conditioning usually speeds up drying, especially on first cut crops, but can also increase vulnerability to rainfall damage and shattering losses during raking or baling. Raking losses increase as moisture content decreases particularly below 40% moisture. Baler pickup and chamber losses can be reduced by raking light windrows together and by travelling at maximum ground speed. Baling losses with large round balers can exceed those with rectangular balers. Legumes are more susceptible to losses than are grasses, whether due to rainfall or to losses during tedding, raking and baling.

Because grasses dry faster than legumes, they are often included in a legume mixture to hasten field drying. However, as protein level is usually lower in grasses than in legumes, care must be taken in harvest and fertility management and in species selection, to keep the percentage of grass at acceptable levels. See Factsheet *Haying with a Large Round Baler*, Agdex 120/745.

In recent years, drying agents and wet-hay preservatives have come on the market, providing additional aids to successful haymaking.

Drying agents such as potassium carbonate, which are applied at the time of cutting, reduce drying time up to a full day when the following rules are observed: (a) apply to legume-dominant stands only, as drying agents do not work on grasses; (b) be generous with the recommended water volume, because the water distributes the product throughout the forage. Uneven distribution can result in hot spots, from which mold will spread in baled hay; (c) lay the cut forage in a wide windrow, to reduce windrow resistance to water loss; (d) be ready to harvest when the hay is ready, to avoid overdrying and leaf loss; (e) remember that a drying agent won't compensate for bad weather or poor harvest management.

Preservatives, which may be applied at baling, allow safe storage of hay baled in excess of safe baling moisture. The last few percentages of moisture are the most difficult to remove. Thus, a product which enables baling at 22 to 25% moisture can reduce field drying time by half a day or more, reducing exposure to rainfall damage and lessening leaf loss. Propionic acid-based preservatives are reliable, provided that care is taken in application.

Hay Marketing Cash crop hay has been gaining interest in Ontario. The strength of the U.S. dollar, relative to the Canadian dollar, has allowed Ontario hay growers to compete in the U.S. horse market. The horse market is very competitive and unpredictable, with buyers purchasing from whoever can supply them with the best product at the best price. Alfalfa/timothy mixtures are the most desirable. Quality is of primary concern, and is usually determined by visual appearance and smell. Unlike other livestock markets, little laboratory analysis (crude protein, acid detergent fiber, etc.) is done on forages for horses. Trainers of valuable recreational horses require a bright green, leafy hay. Extra care must be taken by the grower and trucker to supply hay that is free of dust and foreign material. A firm, tight bale weighing 27 to 32 kg (60 to 79 lb.) is preferred by the American horse market. This weight helps to offset the high cost of long distance hay transport, while still being manageable by the labour hired to unload shipments. To accommodate truckers, suppliers of hay should have good access to year round storage facilities.

Haylage and Silage Ensiling preserves and maintains the nutritional value of forage by creating anaerobic conditions which favor the growth of lactic acid forming bacteria. Production of lactic acid by the bacteria lowers the pH of the forage until it reaches about pH 4.2, after which all bacterial growth ceases. The ensiled forage is then effectively "pickled", and if undisturbed, can remain in this state indefinitely. The longer it takes to reach this state, however, the greater will be the loss of nutritional value due to microbial degradation.

Successful ensiling requires attention to: (a) proper forage moisture content, because moisture excludes air; (b) a tight silo to prevent entry of fresh air; and (c) the availability of sugars, which support the growth of lactic acid forming bacteria. Legumes such as alfalfa are more difficult to ensile than grasses, because legumes resist lowering of the pH more than grasses, and have a lower sugar content.

The application of a bacterial silage inoculant to alfalfa forage at 50 to 65% moisture often increases the rate of fermentation and the degree of acidification of the silage. This can improve silage quality and increase dry matter recovery. There is some indication that the application of an inoculant will reduce the conversion of plant proteins to soluble forms of nitrogen and to ammonia. Silage stability in the presence of air, animal intake, and animal performance may be improved. Bacterial silage inoculants are dried or inactive cultures of lactic acid bacteria. They usually contain *Lactobacillus plantarum* alone or in combination with other bacterial species. When applied to the forage, these bacteria grow and produce lactic and acetic acids. The product should supply at least 100,000 live bacteria (colony forming units) per gram of forage, when applied at the recommended rates. Products which are applied as a liquid solution often are more effective than dry powders.

The application of a bacterial silage inoculant will not overcome the effects of poor ensiling practices or poor weather conditions. The products are most effective when combined with good silo management and top quality forage. See Factsheet, *Quality Hay Crop Silage* (Agdex 120/52).

Management for Pasture

Pasture can provide a significant portion of ruminant nutrition for up to seven months a year in Ontario. Economical pasture management is the result of good crop and animal management.

Crop management begins with the selection of a pasture mixture that is adapted both to the field and to the demands of grazing. Simple mixtures, with one legume and one or two grasses, have been found to be more productive and easier to maintain than more complex mixtures.

Alfalfa and the clovers can cause bloat and should always be seeded with a companion grass. Whenever the pasture has more than 40% of a bloating legume (the content can fluctuate during the season due to such factors as weather) precautions to prevent bloat should be taken. These include feeding hay to the animals to limit their intake of fresh pasture and allowing them to initially graze only for short periods of time. Proloxene can also be fed.

Species which are productive and persistent under intensive grazing are orchardgrass, reed canarygrass, meadow foxtail, the fescues, the bluegrasses and white clover. Species which tolerate less intensive grazing are bromegrass, timothy and bird's-foot trefoil. Sheep, goats and horses graze close to the ground and pasture management is made easier by selecting forage species that tolerate close grazing. Cattle graze best when the forage is 12 to 15 cm tall and will produce poorly if the pasture is allowed to get too short. Any of the recommended forage species are suitable for cattle pastures.

FORAGE SPECIES	Frequent, Close Grazing	Rotational Grazing	Stored Feed
Alfalfa	☐	◪	■
Birdsfoot trefoil	☐	■	■
Red clover	☐	◪	■
White clover	■	■	◪
Alsike clover	☐	◪	◪
Sweetclover	☐	◪	◪
Bromegrass	☐	◪	■
Timothy	☐	◪	■
Reed canarygrass	☐	■	■
Orchardgrass	■	■	■
Perennial ryegrass	■	■	■
Annual ryegrass	■	■	■
Tall fescue	☐	◪	■
Meadow fescue	☐	◪	■
Creeping red fescue	■	■	☐
Meadow foxtail	☐	◪	☐
Kentucky bluegrass	■	■	☐

■ Highly Suitable

◪ Suitable

☐ Not Recommended

Figure 4 Suitability of Forage Species to Harvest Management

To maintain production, pasture soils should be periodically tested and fertilized annually. Phosphorus and potash are essential for both legumes and grasses. Grass pastures will also require nitrogen fertilizer, preferably in split applications during the spring and summer. Some or all of the nitrogen requirements may be met by manure. Harrowing occasionally will benefit the pasture by spreading the nutrients in the droppings and by reducing losses by fouling. If nitrogen fertilizer is used on mixed legume grass stands, the resulting grass growth should be harvested or grazed off to avoid crowding out the legumes. For more information, refer to *Fertilizers for Forage Crops.*

Livestock that have been prepared to gain by means of winter-feeding, worming, and general conditioning will profit most from investment in good crop and grazing management.

Grazing management influences seasonal yield, grazing efficiency, and persistence. Harvest efficiency by grazing stock drops sharply when the pasture is kept either too tall and mature or too short and sparse. A pasture is ready to graze when forage growth is about 15 to 20 cm tall, and before the grasses have headed out. With most forage species, some 8 to 10 cm of bottom residue should be left after grazing to support vigorous regrowth. Regrowth to acceptable grazing height requires from 20 to 25 days in the spring and from 30 to 35 days in summer, for most forage species. Stocking rate should vary with seasonal trends in forage production, from a high in spring to a low in the fall. For further information, see OMAF Publication 19, *Pasture Production* and OMAF Factsheet, *Pasture Renovation,* Agdex 136/22.

Adaptation of Forage Species and Varieties

Alfalfa

When managed for quality feed, alfalfa usually persists for three or four years. Alfalfa-based mixtures produce higher yields of stored feeds or green chop than any other mixture. For high

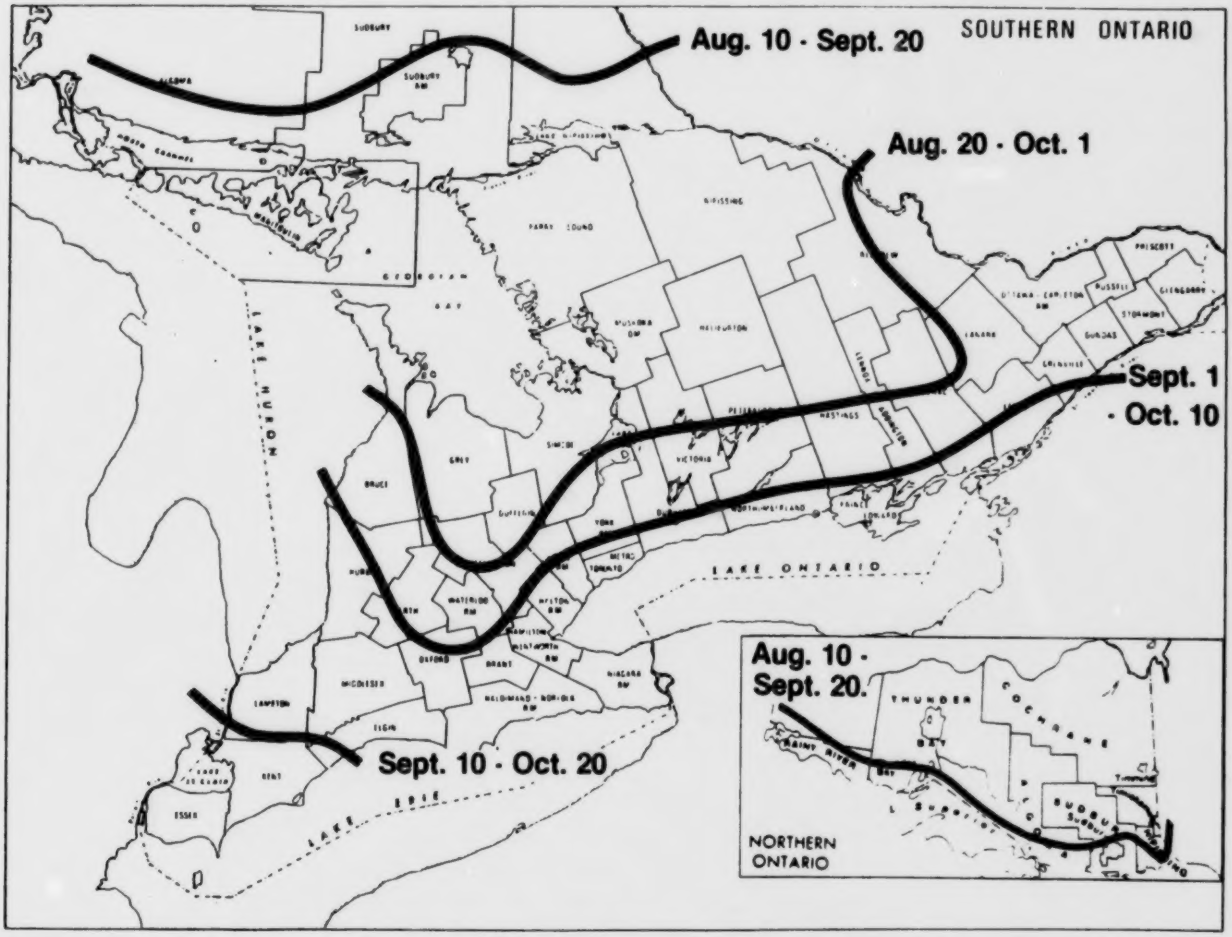

Figure 5. Critical Fall Harvest Period for Alfalfa

To ensure persistence and succeeding yields, do not harvest alfalfa during the critical harvest period shown on the map for each region.

yields and persistence, alfalfa requires well drained soil, adequate phosphorus and potash, a pH above 6.0, and proper harvest management.

Alfalfa is sensitive to winter stresses. Application of potassium (see Fertilizers for Forage Crops) after the last harvest will increase the level of tolerance to low temperature. Harvests should be timed to allow uninterupted growth during the "critical fall harvest period". This allows the plants to build up root energy reserves and produce sufficient top growth which will hold snow and insulate the overwintering plant. This ensures vigorous spring

Table 28. Recommended Alfalfa Varieties (Saranac-type Fall Dormacy)

	Yield (% of Saranac)		Disease Reaction[2]			
Variety	**S. Ontario**	**N. Ontario**	**Verticillium Wilt**	**Phytophthora Root Rot**	**Bacterial Wilt**	**Distributor[1]**
Admiral	101	95	MR	R	R	First Line Seeds
Advance	104	—	R	S	R	Pickseed
Alouette	99	103	S	S	R	Pickseed
Anchor	99	99	S	S	R	Oseco Inc.
Angus	98	101	S	S	HR	Public
Apica	104	103	S	S	R	United Co-operatives of Ontario
Apollo II	98	95	MR	HR	R	Oseco Inc.
Armor	102	100	S	R	R	Oseco Inc.
Arrow	104	104	R	HR	HR	Pickseed
Award	101	—	S	S	R	Speare Seeds
Bell Ringer	103	—	MR	S	R	King Agro
Blazer	102	100	S	MR	HR	Oseco Inc.
Citation	102	104	S	S	R	Mapleseed Inc.
Classic	100	96	S	S	R	United Co-operatives of Ontario
Crusader	100	102	S	S	R	Pride Brand Seeds
DK-125	102	102	R	R	HR	Dekalb Canada
DK-135	101	97	MR	MR	MR	Dekalb Canada
Eagle	100	97	MR	MR	HR	Cargill Hybrid Seeds
Edge	102	105	MR	R	R	First Line Seeds
Excalibur	103	103	MR	S	R	United Co-operatives of Ontario
G2852	104	—	R	R	HR	Funk Seeds
Hunter	99	99	S	S	R	Rothwell Seeds
Husky	102	103	S	MR	R	Oseco Inc.
Magnum +	101	—	S	MR	R	Funk Seeds
88	102	99	MR	MR	R	Mapleseed Inc.
Peak	101	101	S	MR	R	Oseco Inc.
Pinnacle	101	101	R	MR	HR	Hyland Seeds
532	103	101	S	S	HR	Pioneer Hi-Bred
Preserve	103	100	S	MR	R	Northrup King
Primal	102	100	S	S	HR	Pride Brand Seeds
Regal	101	95	S	S	HR	United Co-operatives of Ontario
Saranac	100	100	S	S	R	Public
Spectrum	101	98	S	MR	R	Labonté Seeds, Hyland Seeds
Surpass	103	—	R	R	R	Oseco Ltd.
Thor	100	100	S	S	HR	Northrup King Seeds
Tomahawk	103	—	MR	MR	R	Speare Seeds
Trumpetor	98	98	MR	S	MR	Northrup King Seeds
Turbo	101	99	S	R	R	Pickseed
Verta +	104	102	R	HR	HR	Speare Seeds
Vista	99	99	S	S	R	Pickseed, Mapleseed Inc.
WL 316	101	96	MR	S	MR	King Agro, Speare Seeds

Average yield of Saranac in Southern Ontario trials 12.1 t/ha, in Northern Ontario trials 7.4 t/ha.

[1] *See Distributor Addresses in General Information section.*

[2] *Note the new rating system for disease resistance as listed below.*

HR = Highly Resistant (more than 50% resistant plants).
R = Resistant (31 to 50% resistant plants).
MR = Moderately resistant (15 to 30% resistant plants).
S = Susceptible (less than 15% resistant plants).

Table 29. Recommended Alfalfa Varieties (Iroquois-type Fall Dormancy)

	Yield (% of Iroquois)		Disease Reaction[2]			
Variety	**S. Ontario**	**N. Ontario**	**Verticillium Wilt**	**Phytophthora Root Rot**	**Bacterial Wilt**	**Distributor[1]**
Algonquin	97	102	S	S	HR	Public
Ambassador	105	100	MR	R	R	Pickseed
Centurion	102	100	R	R	HR	United Co-operatives of Ontario
Comsel	101	—	S	HR	R	Norcan Seeds Inc., Speare Seeds
Crown	103	102	MR	R	R	Cargill Hybrid Seeds
120	104	102	S	R	HR	Dekalb Canada
Glory	102	100	S	S	R	Speare Seeds
Iroquois	100	100	S	S	HR	Public
Magnum	101	101	S	S	R	Funk Seeds
Mohawk	100	—	S	S	R	Rothwell Seeds, United Co-operatives of Ontario
Noble	102	—	S	S	R	United Co-operatives of Ontario
OAC Minto	103	102	S	S	R	Speare Seeds, Bishop Seeds
Olinda	100	—	S	HR	R	SeCan member
Oneida VR	102	—	R	R	R	Pickseed
526	103	96	S	S	R	Pioneer Hi-Bred
Shield	102	97	R	R	HR	Rothwell Seeds
Sure	104	103	R	R	HR	Northrup King Seeds
Thunder	100	95	S	R	R	Oseco Inc.
Ultra	102	—	R	HR	HR	Hyland Seeds
Valor	100	98	S	S	R	Rothwell Seeds
WL 222	101	98	S	MR	R	King Agro, Speare Seeds

Average yield of Iroquois in Southern Ontario trials 12.1 t/ha, in Northern Ontario trials 7.1 t/ha.

[1] See Distributor Addresses in General Information section.

[2] Note the new rating system for disease resistance as listed below:
HR = Highly Resistant (more than 50% resistant plants).
R = Resistant (31 to 50% resistant plants).
MR = Moderately resistant (15 to 30% resistant plants).
S = Susceptible (less than 15% resistant plants).

growth, stand persistence, and reduces damage due to heaving. Cutting during the critical fall harvest period reduces the amount of top growth, thus reducing the potential insulation around the overwintering tissue. The critical fall harvest period is approximately a 6-week period prior to the first killing frost, and varies with location in the province. Regional dates for the critical fall harvest period are shown in Figure 5 for alfalfa.

Since alfalfa can cause bloat on pasture, caution and judgement are required if it is used for pasture.

The alfalfa varieties are divided into two groups based on their fall growth habit. The amount of fall growth reflects the variety response to shortening daylengths and cooler temperatures in the fall. As the daylength gets shorter, Iroquois-type varieties grow less following the last cutting compared to Saranac-type varieties. In other words, Iroquois-type varieties show somewhat greater fall dormancy than do Saranac-type varieties. There are no consistent differences in yield or persistence between the two groups.

There are no significant differences in protein level between alfalfa varieties. The major factor influencing protein levels of alfalfa is maturity at harvest.

Bird's-foot Trefoil

Bird's-foot trefoil is a legume which is well suited to permanent pasture. If managed to allow natural reseeding, trefoil pastures can remain productive for 10 or more years. Although lower yielding than alfalfa, it is well adapted to steep rolling land or where drainage or pH are marginal for other legumes. Heavy grazing or cutting of trefoil during the critical fall harvest period will weaken the stand and reduce vigor the following year. In Southern Ontario, the critical fall harvest period for bird's-foot trefoil is about 10 days earlier than for alfalfa at any given location (Figure 5). In Northern Ontario, the period shown in Figure 5 for alfalfa can also be applied to bird's-foot trefoil.

Bird's-foot trefoil is a nonbloating legume, which is especially advantageous for pasture use.

Table 30. Recommended Bird's-foot Trefoil Varieties

Variety	Yield (% of Leo) S. Ontario	N. Ontario	First Flower (Guelph)	(Kapuskasing)	Regrowth	Variable Drainage Tolerance	Distributor[1]
Leo	100	100	June 23	June 30	Medium to Slow	Good	Public Variety
Upstart	102	97	June 23	June 30	Medium to Slow	Good	Pickseed
Empire	98	98	July 1	July 7	Slow	Excellent	Public Variety

[1]*See Distributor Addresses in General Information section.*

Average yield of Leo in Southern Ontario trials 8.5 t/ha; in Northern Ontario trials 6.1 t/ha.

Red Clover

Red Clover is a short-lived perennial which is best suited to short-term haylage or silage production, as red clover is difficult to cure as hay. Timothy is the best grass to use with red clover. It is usually not recommended in pasture mixtures because of its poor persistence, its ability to suppress other legume establishment in the seeding year, and its tendency to cause bloat. However, it is very useful for renovating run-down pastures by broadcast seeding or "frost" seeding. The competitive nature of red clover insures a good catch and a rapid and substantial increase in pasture yield. Normally the catch will not be great enough to be a bloat hazard. See Factsheet *Pasture Renovation*, Agdex 136/22.

Red clover is a bloat-causing legume which should be used only with caution and judgement in a pasture mix.

Double-cut or "medium" red clover is generally more popular than single-cut or "mammoth" red clover. Double-cut red clover will flower in the seeding year, and regrowth after cutting is strong and vigorous. Single-cut red clover is slower growing, with larger stems, and matures about two weeks later than double-cut. It does not flower in the seeding year, or after the first cut in succeeding years.

The recommended double-cut varieties of red clover tend to be more persistent than commercial Canada #1 double cut, and are recommended wherever the stand will be harvested for more than one year.

Red Clover Plowdown High seedling vigor and rapid establishment have made red clover a popular crop for soil improvement in cash crop rotations. When sown for plowdown, red clover is usually seeded with a cereal crop and then plowed under in late fall of the establishment year or early the next spring. Red clover seed may be broadcast or included in the spring application of dry or liquid nitrogen on winter wheat. When establishing red clover under a spring grain, cereal seeding will minimize lodging and harvest problems. When used in this manner, a full stand 40 cm in height at fall plowing can contribute excellent soil tilth and substantial nitrogen to the following crop (see *Nitrogen Adjustment of Legumes Plowed Down*). Generally, double-cut red clover produces more top-growth than single-cut.

There appears to be no advantage to sowing pedigreed vs common lots of red clover, or to leaving the stand down for more than one year before plowing it under. On land with no history of red clover, inoculation of the seed with the appropriate Rhizobium culture will ensure the nitrogen contribution.

White Clover

White clover is a short-lived perennial which persists as a stand primarily by self-seeding. Unlike the other legumes, white clover stems are horizontal rather than vertical, which makes white clover particularly well adapted to close, intensive grazing. It is exceptionally palatable and digestible, because the grazed forage is almost entirely leaves.

Table 31. Recommended Double-Cut Red Clover Varieties

	Yield (as % of Florex)						
	Southern Ontario		Northern Ontario		First Flower		
Variety	Year 1	Year 2	Year 1	Year 2	(Guelph)	(Kapuskasing)	Distributor[1]
Arlington	98	92	92	91	June 15	June 29	Public Variety
Atlas	102	97	—	—	June 16	June 30	Northrup King Seeds
Florex	100	100	100	100	June 18	July 2	Northrup King Seeds Mapleseed Inc.
Prosper 1	100	94	99	99	June 18	July 2	King Agro
Persist	101	98	—	—	June 19	July 3	Northrup King Seeds

[1]*See Distributor Addresses in General Information section.*

Average yield of Florex, Southern Ontario trials 9.7 t/ha; in Northern Ontario trials 6.3 t/ha.

Table 32. Recommended White Clover Varieties

Variety	Yield (% of Sacramento)		Distributor[1]
	S. Ontario	N. Ontario	
California Ladino	105	103	Public Variety
Merit	107	—	Public Variety
Sacramento	100	100	Tib Szego Associates Ltd.

[1] See Distributor Address in General Information Section.
Average yield of Sacramento, Southern Ontario trials 6.2 t/ha; in Northern Ontario trials 5.0 t/ha.

White clover is a bloating legume, but because of its low growth habit, it seldom accounts for a large enough share of total yield to constitute a hazard.

Of the three general types of white clover — ladino, white Dutch and small wild white — ladino is the most vigorous. Compared to the other types, ladino white clover is distinguished by greater height and broader leaf blades, and is the type most commonly sown in Ontario.

Sweetclover

Sweetclover is a biennial legume with a deep tap root that is useful for soil improvements, pasture, hay and silage. It is valued as a "bee" plant as it is a good source of nectar and pollen and produces a honey that is favored by consumers.

Sweetclover grows slowly in the first year and does not flower. In the spring of the second year, sweetclover grows quickly becoming a tall, coarse-stemmed plant ranging in height from 150 to 200 cm.

There are two types of sweetclover, white flowered and yellow flowered. White sweetclover is deeper rooting, taller and coarser than the yellow type and is therefore more suitable for plowdown. Yellow sweetclover is more palatable to livestock and more attractive to bees.

Mouldy sweetclover hay may contain dicoumarol, which can prevent normal blood clotting and result in the death of livestock from bleeding. The low coumarin yellow-blossom variety Norgold has reduced potential for formation of dicoumarol. Sweetclover can cause bloat when pastured.

Timothy

Timothy is the most widely sown forage grass in Ontario, primarily because of its compatibility with alfalfa for either hay or silage. It is a bunchgrass with limited tillering ability, making it non-aggressive when sown with other grasses or legumes. Because of its very small seed, it is easy to establish in mixture with small seeded legumes. Because it is well adapted to heavier soils and variably drained fields, timothy is commonly sown as stand insurance in new seedings with legumes. Although palatable and high yielding in the spring, it tends to have weaker regrowth than the other grasses, and is susceptible to midseason drought and high temperature.

Bromegrass

Bromegrass is a more aggressive grass than timothy owing to its rhizomatous growth habit. It is earlier than timothy, and more drought tolerant, resulting in somewhat better midseason production than timothy. Its real strength is in spring and fall growth.

Brome is palatable and tends to retain its nutritional value with increasing maturity better than most grasses. Its weaknesses include a very large seed size, which makes seeding more difficult and a rhizomatous growth habit, which makes it a stronger competitor than timothy when sown with alfalfa.

Table 33. Recommended Timothy Varieties

Variety	Yield (% of Climax)		Heading Date		Regrowth	Distributor[1]
	S. Ontario	N. Ontario	(Guelph)	(Kapuskasing)		
Salvo	98	99	June 16	June 22	Good	SeCan Member
Toro	98	101	June 20	July 3	Good	Oseco Inc.
Basho	99	103	June 22	July 2	Good	Public
Richmond	98	103	June 22	July 2	Fair	Mapleseed Inc., Pickseed
Champ	98	108	June 23	July 1	Good	Public
Mariposa	102	97	June 24	July 2	Good	United Co-operatives of Ontario
Itasca	101	104	June 25	July 3	Fair	United Co-operatives of Ontario
Alexander	100	98	June 26	July 4	Fair	Speare Seeds
Argus	104	104	June 26	July 4	Fair	Oseco Inc.
Timfor	101	103	June 26	July 3	Fair	Northrup King Seeds
Climax	100	100	June 28	July 5	Fair	Public
Glenmor	103	—	June 28	July 3	Good	Northrup King Seeds
Winmor	104	99	June 29	July 6	Fair	Northrup King Seeds

[1] See Distributor Addresses in General Information section.
Average yield of Climax, Southern Ontario trials 10.9 t/ha; in Northern Ontario trials 7.5 t/ha.

Table 34. Recommended Bromegrass Varieties

Variety	Yield (% of Baylor) S. Ontario	Yield (% of Baylor) N. Ontario	Heading Date (Guelph)	Heading Date (Kapuskasing)	Distributor[1]
Baylor	100	100	June 10	June 26	Oseco Inc.
Beacon	98	103	June 10	June 25	Oseco Inc., United Co-operatives of Ontario
Bravo	97	104	June 10	June 25	Pickseed
Saratoga	95	102	June 10	June 24	Public
Tempo	93	102	June 10	June 24	Pickseed, Mapleseed Inc.

[1] *See Distributor Addresses in General Information section.*
Average yield of Baylor, Southern Ontario trials 10.9 t/ha; in Northern Ontario trials 7.2 t/ha.

Orchardgrass

Orchardgrass is earlier and much more aggressive than either timothy or brome. It is a bunch grass, and will tend to form tough, unpalatable clumps unless used to its potential. Orchardgrass requires much more frequent and intensive harvest than would be appropriate for either timothy or bromegrass. It responds well to high rates of nitrogen and regrows rapidly, especially in the spring. It is reasonably palatable when young, but loses both palatability and digestibility faster than other grasses if allowed to mature. It is the most drought-tolerant grass available in Ontario, but it does require well-drained soils to perform well. Icing or flooding will kill orchardgrass more easily than other grasses.

Reed Canarygrass

Reed canarygrass is best known for its exceptional tolerance of excessive soil moisture, including prolonged flooding. It is very high yielding for either long term hay or pasture, under both high moisture and droughty conditions. Due to its rhizomatous growth habit, reed canarygrass is very aggressive when sown with other species. It loses palatability and digestibility fairly quickly if not kept grazed down. Due to its coarse leaves and stems, it is better stored as haylage or silage than as hay.

In the past, reed canarygrass varieties contained alkaloids, which depress gains and performance in livestock. At present, however, all recommended varieties are free of the undesirable tryptomine and carboline alkaloids.

Table 35. Recommended Orchardgrass Varieties

Variety	Yield (% of Hallmark) S. Ontario	Yield (% of Hallmark) N. Ontario	Heading Date (Guelph)	Heading Date (Kapuskasing)	Distributor[1]
Hallmark	100	100	June 2	June 15	United Co-operatives of Ontario
Juno	100	102	June 2	June 15	Mapleseed Inc., Pickseed
Rapido	103	94	June 4	June 16	Pickseed
Napier	101	102	June 8	June 16	Oseco Inc.
Rancho	96	106	June 10	June 16	United Co-operatives of Ontario
Sumas	103	103	June 12	June 18	Oseco Inc.
Kay	101	106	June 12	June 18	Oseco Inc.

[1] *See Distributor Addresses in General Information section.*
Average yield of Hallmark, Southern Ontario trials 9.6 t/ha; in Northern Ontario trials 6.5 t/ha.

Table 36. Recommended Reed Canarygrass Varieties

Variety	Yield (% of Vantage) S. Ontario	Yield (% of Vantage) N. Ontario	Heading Date (Guelph)	Heading Date (Kapuskasing)	Distributor[1]
Vantage	100	100	June 10	June 24	Oseco Inc.
Venture	102	90	June 11	June 24	Speare Seeds
Palaton	99	94	June 11	June 25	Oseco Inc.

[1] *See Distributor Address in General Information Section.*
Average yield of Vantage, Southern Ontario trials 11.8 t/ha; in Northern Ontario trials 8.5 t/h.

Table 37. Recommended Meadow Foxtail Varieties

Variety	Heading Date		Distributor[1]
	(Guelph)	(Kapuskasing)	
Dan	May 15	May 30	Oseco Inc.

[1]See Distributor Address in General Information Section.
Average yield of Dan, Southern Ontario trials 9.0 t/ha; in Northern Ontario trials 5.6 t/h.

Meadow Foxtail

Meadow foxtail is a long-lived perennial grass which resembles timothy in appearance and is well adapted to intensive pasture management. It performs well on poorly drained soils, has very early spring growth, and responds well to nitrogen. Mid-summer production during periods of high temperature and drought may be low. Seed is light, fluffy and hairy, and therefore, should be coated prior to seeding.

Tall Fescue

Tall fescue is a coarse leafy grass useful in long-term pasture and in erosion control. It is adapted to most soil types, tolerant of imperfect drainage, and withstands animal traffic well. Recently, a seed-borne systemic fungus (an endophyte) has been linked to poor animal performance on tall fescue pasture. Endophyte-free seed is available and should be sown when tall fescue is seeded for pasture. Once introduced by infected seed, the fungus can not be controlled in an established stand of tall fescue.

Creeping Red Fescue

Creeping red fescue is a dense, sod-forming grass which establishes and spreads vigorously on most soil types, including well-fertilized subsoils. Its solid underground root system and thick, fine, leafy top growth make creeping red fescue an excellent grass for streambank or grass waterway protection. It can also serve as a bottom grass in long-term pastures, and is noted for its extended growth and retained nutritional value in the fall.

Meadow Fescue

Meadow fescue is a hardy grass used in hay and pasture mixtures. It yields well during the summer and fall and maintains its feed quality later into the season than most grass species.

Meadow fescue is smaller and has finer leaves than tall fescue. Meadow fescue also has a more shallow root system and does not live as long as tall fescue.

Perennial Ryegrass

Perennial ryegrass is a short-lived perennial that comes in turf-, pasture- and hay-adapted varieties. The more recently introduced pasture- and hay-adapted varieties have not yet been shown to have adequate winterhardiness for widespread use in the province. No varieties are yet recommended for use in Ontario. Management of perennial ryegrass is different from that of timothy or brome. It is early and vigorous in the spring, and grows particularly well into the fall. It regrows quickly, enabling frequent, intensive grazing or harvest. Winterkilling is promoted by excessive top growth going into the winter, and by late nitrogen application. The pasture-adapted varieties tend to have finer leaves, smaller and more numerous tillers, and later maturity than the hay varieties. Perennial ryegrass is exceptionally palatable and digestible, and is less competitive than orchardgrass, making it a suitable component of high quality alfalfa or white clover mixtures.

Annual Ryegrass

Annual ryegrass is a rapidly growing bunch grass that is adapted to a wide range of soil conditions. It is a useful species for mid to late season production and is very responsive to nitrogen fertilization. Two types of ryegrass are available and they differ remarkably in their growth habit. The Italian ryegrasses are actually short-lived perennials. However, under Ontario winter conditions, there is usually 100% winterkill. When grown as an annual, the Italian ryegrass remain vegetative, producing a lush leafy growth that usually doesn't grow taller than 40 cm. It is an ideal pasture species and can be grazed as often as five or six times. The Westerwold type is a true annual. It will produce a variable number of heads depending on the variety. The Westerwolds varieties grow to 40-80 cm high making them suitable for pastures or hay crops. Feed quality decreases rapidly after heading.

Bluegrasses

Two common bluegrasses in Ontario, Canada and Kentucky, grow on about one million hectares of permanent pasture land. The dense but shallow rooted bluegrasses produce lush, palatable growth during the springtime but low yields during the dry, hot midsummer in Southern Ontario.

Properly fertilized and managed, bluegrass production can be markedly improved, especially in the cooler climate of Northern Ontario. In pastures, they serve as a bottom grass that controls weed invasion, withstands close grazing and tramping, and creeps and fills in where other species thin out.

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Table 38. Characteristics of forage species grown in Ontario

Species	Suitable For	Persistence, years	Strengths	Cautions
Alfalfa	-Stored Feed	3-4 S. Ont. 2-4 N. Ont.	-Excellent quality -Excellent yield	-May cause bloat -Poor persistence under grazing -Low tolerance to acid or variably drained soil -Needs fall rest period
Bird's-foot Trefoil	-Stored Feed -Pasture	up to 10	-High quality -No bloat hazard -Good tolerance to acid and variably drained soil	-Slow to establish -Slow spring growth and regrowth -Needs fall rest period
Red Clover	-Stored Feed -Plowdown -Pasture	1-2 S. Ont. 2-3 N. Ont.	-Excellent 1st year yield -Easy to establish -High quality -Good tolerance to acid or variably drained soil	-May cause bloat -Stand thins rapidly -May cause temporary infertility in grazing sheep -Very competitive, especially with other legumes
White Clover	-Pasture	5 +	-Excellent quality and palatability -Good tolerance to close grazing	-May cause bloat -Low drought tolerance
Alsike Clover	-Stored Feed -Pasture	5 +	-Very good tolerance to wet, acid soils -Good quality	-No consistent production from year to year -May lower yields when added to mixtures -May cause bloat
Sweetclover	-Plowdown -Stored Feed -Pasture	2	-Excellent soil builder -Opens up subsoil -Excellent "bee" pasture	-Low palatability unless harvested early -Coumarin content in older varieties causes feeding difficulties
Timothy	-Stored Feed	5 +	-Easy to establish -Good tolerance to variable drainage -Seed is inexpensive	-Poor summer production -Poor resistence of late varieties under 3-cut harvest system
Bromegrass	-Stored Feed -Pasture	5 +	-Excellent spring/fall yield -Good regrowth -Retains quality with maturity	-Large seed size creates seeding problems -More aggressive than timothy
Orchard-grass	-Pasture -Stored Feed	5 +	-Very early pasture -Excellent regrowth -Good drought tolerance -Good tolerance of close grazing -Very responsive to N	-Rapidly loses quality and palatability with maturity -Very competitive with other species -Poor tolerance to variable drainage and icing
Reed Canary-grass	-Stored Feed -Pasture	5 +	-Excellent yield on both variably drained and dry soils -Good regrowth	-May be slow to establish -Rapidly loses quality and palatability with maturity -Very competitive with other species
Meadow Foxtail	-Pasture	5 +	-Easy to establish -Excellent, very early yield -Excellent tolerance to variably drained soil	-Need to use coated seed -Very competitive with other species -Low drought tolerance
Tall Fescue	-Stored Feed -Pasture -Grass Waterways	5 +	-High yield -Good summer growth -Good feed quality in fall -Good tolerance to acid soils	-Low palatability -Need endophyte-free seed -Coarse leaves

Table 38. Characteristics of forage species grown in Ontario (Cont.)

Species	Suitable For	Persistence, years	Strengths	Cautions
Creeping Red Fescue	-Pasture -Grass Waterways	5 +	-Good feed quality in fall -Easy to establish -Good tolerance to close grazing and to acid soils -Good regrowth -Excellent soil builder	-Low seasonal yield -Low palatability
Meadow Fescue	-Stored Feed -Pasture -Grass Waterways	5 +	-Good summer yield -Good feed quality in fall -Fine leaves attractive to livestock -Good tolerance to acid soils	-Less persistent and lower yielding than tall fescue -Slow to establish
Perennial Ryegrass	-Pasture -Stored Feed	2-3 S. Ont.	-Excellent quality and palatability -Establishes very quickly -Good regrowth -Good tolerance of close grazing	-Poor drought tolerance -Poor tolerance to variably drained soils -Variable persistence
Annual Ryegrass	-Pasture -Stored Feed	1-2	-Excellent quality -Establishes quickly -Good fall yield -Good tolerance of close grazing	-Poor drought tolerance -Very competitive with other species
Kentucky Bluegrass	-Pasture -Grass Waterways	5 +	-Good quality and palatability -Good tolerance of close grazing	-Poor summer production -Very slow to establish -Low seasonal yield

Table 39. Recommended forage mixtures for stored feed and pasture

Components	Seeding Rate[1] kg/ha	Recommended For			Specific Recommendations
		Stored Feed	Pasture	Intensive Pasture	
1. Alfalfa	13	X			Only on well-drained fields where alfalfa persists well. Easier to cure as silage than as hay. Harvest at bud stage for high protein feed.
2. Alfalfa, Timothy	13,1	X			Timothy is included as stand insurance and for weed control in areas of the field less suited to alfalfa. Increase timothy to 4 kg/ha for easier curing. Harvest at bud stage for high protein feed.
3. Alfalfa, Brome	11,9	X			Preferred over alfalfa-timothy on dry soils, or areas with over 3100 CHU. Same quality and curing characteristics as timothy mixtures.
4. Alfalfa, Orchard	11,6	X		X	Select late orchard and early alfalfa varieties. Graze or cut early to maintain quality and palatability. Percentage grass higher in second and third cuts than in either timothy or brome mixtures.

(Continued on Page 42)

Table 39. Recommended forage mixtures for stored feed and pasture (Cont.)

Components	Seeding Rate[1] kg/ha	Recommended For			Specific Recommendations
		Stored Feed	Pasture	Intensive Pasture	
5. Alfalfa, Orchard and White Clover	9,2,2	X		X	As 4. High fertility and good grazing management needed for top production. Alfalfa included as insurance against drought, but requires longer regrowth intervals to persist.
6. Alfalfa, Timothy Brome, White Clover	9,4,9,2	X		X	Suitable for hay/pasture combinations.
7. Alfalfa, Orchard Brome, White Clover	9,3,9,2	X		X	As 6, but will provide earlier feed and a higher percentage grass in regrowth.
8. Trefoil, Timothy	9,2	X			Match maturities of trefoil and timothy varieties.
9. Trefoil, Brome	9,4	X	X		For long-term stands and early production. Graze early to reduce competition from brome. Good yields in fall.
10. Trefoil, Orchard	8,4			X	Good early and midseason production. Graze down orchard to reduce competition with trefoil. Later maturing orchard varieties are preferred.
11. Trefoil, Meadow Foxtail[2]	9,10			X	Extra early production. Graze early to reduce competition from grass. Good tolerance to poor drainage.
12. Trefoil, Tall Fescue[3]	8,10	X	X		Good production throughout the season. Good growth and quality in the fall.
13. Trefoil, Creeping Red Fescue	8,6		X		Good summer and fall production. Excellent quality in fall.
14. Red Clover	11	X			Short-term production or plowdown crop.
15. Red Clover, Timothy	7,6	X			Short-term production. When clover disappears, plowdown or fertilize to maintain production.
16. Red Clover Alsike, Timothy	7,2,6	X			As 15, but less clover can be expected in second year. Alsike is more tolerant of acid soils and poor drainage.
17. White Clover, Orchardgrass	2,9			X	For pasture use where white clover is adapted. High fertility, adequate moisture, and good grazing management required for top production. In dry areas add alfalfa (see 5 above)

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[1] *For early seeding on a fine, firm seedbed, these rates may be reduced by 25% except where coated seed is being used.*

[2] *Use coated seed. It can be seeded through the grain seed box.*

[3] *Use endophyte-free seed.*

ANNUAL CROPS FOR FORAGE IN SOUTHERN ONTARIO

SPRING PASTURE

Autumn-seeded fall rye or **winter triticale** can be grazed for a short period in the spring, preferably after the stems start to form. Seed fall rye at 150 kg/ha, and winter triticale at 100-125 kg/ha. Keep stock off when wet.

SUMMER GREEN CHOP OR PASTURE

Sudan Grass Hybrids, Sorghum Hybrids, Sorghum-Sudan Hybrids Seed from mid May to early June at about 14 kg/ha in 18 or 36 cm drill rows. Broadcast seeding may be used when growing these hybrids for pasture. The crop is ready for green chop or grazing by late July-August. Do not graze before 75 cm high or during poor growing conditions as **prussic acid poisoning** could occur. If frozen, allow three days following frost before grazing to avoid prussic acid poisoning. Aftermath yields are moderate but high if warm moist weather prevails. Under good nitrogen fertility, these crops can produce large quantities of nutritious, palatable herbage. They are particularly useful to supplement permanent pastures during August and September. These hybrids are not recommended in short season areas because of inconsistent yields and danger of prussic acid poisoning.

Cereals Seed any time in the season to produce pasture in six to eight weeks. Seed at 100 kg/ha. Barley is higher yielding than oats, but has lower palatability. Thus, it is better used as silage than as pasture. If pastured early, the cereals show some regrowth. If grazed where the stems are forming, no aftermath production can be expected.

AUTUMN PASTURE

Oats Seeded at 100 kg/ha between mid July and mid August, ready for grazing in six weeks.

Fodder rape Seed in early to late July at 1.7 kg/ha in 71 cm rows. May be seeded in solid stands, but yields are 25% lower. Pasture in late October. Makes good hog, sheep, or beef pasture. Taints milk and the meat of animals being finished solely on rape.

Marrowstem kale Seed from early June to mid-August. Pasture is available eight weeks after seeding. Seed at 2 kg/ha in 71 cm rows or broadcast seed 7 kg/ha. Kale is palatable to all classes of livestock and does not produce off flavors in milk or meat if fed in moderate amounts. Do not graze breeding ewes at mating or in late pregnancy because of the possibility of kale having a high goitrogen content. The varieties **Maris Kestrel** and **Gruner Angiliter** are recommended. Maris Kestrel is distributed by Bishop Seeds. Gruner Angiliter is distributed by Pickseed and Mapleseed Inc.

Fall rye or **Winter Triticale** Either species gives good fall pasture by October 1. Seed rye at 150 kg/ha and triticale at 120 kg/ha.

SILAGE CROPS

Corn is the most productive silage crop. Any of the cereals make satisfactory silage harvested by the early dough stage. The sudan grass, sorghum and sorghum-sudan hybrids can also be made into silage.

FORAGES FOR SOIL CONSERVATION

In addition to their role in livestock nutrition, forages may be grown and managed for several additional uses. Legumes such as red clover and sweet clover have long been used as nitrogen-fixing, green manure or plowdown crops, to add organic matter and nitrogen to arable land. Cover crops such as buckwheat or fall rye can be seeded into or after a cereal crop to fill in the rest of the season. These cover crops become a source of soil-conserving organic matter and also act as smother crops to control weeds growth. They also act as conservers of nutrients, by using those nutrients in the soil and in manure applied in midseason, that may have been lost due to leaching, erosion or volatilization if the crop were not present.

Sod-forming grasses, such as tall fescue and creeping red fescue, are favoured for erosion control for waterways, terraces and buffer strips. Their dense fibrous rooting system holds down the soil and enables water to run off safely. On steep, erosion-prone slopes, crownvetch, birdsfoot trefoil or the fescues can be sown to stabilize the soil.

Table 40. Recommended Species for Soil Conservation

Application	Species	Seeding Rate, kg/ha	Comments
Plowdown and/or Cover Crop	Red Clover	11	Double-cut is usually favoured over single-cut red clover: May be seeded under winter wheat or spring grains; or direct seeded for one or more harvests prior to plowdown.
	Sweetclover	10	Tall, deep-rooting, biennial legume best suited to well-drained, neutral to alkaline soils; drought-resistant; good for opening up compacted soils.
	Fall Rye	150	Vigorous green manure and smother crop; may be allelopathic to some crops if plowed down just prior to seeding.
	Buckwheat	50	Heavily branching, shallow-rooting, vigorous, annual, smother crop; can be seeded up to late July, but needs 10-12 weeks if grown for seed; shatters easily.
Erosion Control, Ground Cover	Crownvetch	16	Perennial legume for well-drained sites, such as embankments; forms dense, heavy surface mat; unsuitable for acid soils; often difficult to establish.
	Birdsfoot Trefoil	13	Empire-type varieties are preferred. Should be seeded with a grass. Blends well with creeping red fescue.
	Tall Fescue	22	Good on high-traffic locations, and for erosion control on diversion terraces, grass waterways, and farm pond dams; tolerant of poor drainage.
	Creeping Red Fescue	35	Similar uses to tall fescue, but particularly well adapted to dry sites; vigorous fibrous root system.

Most of the mixtures sown for stored feed (Table 39) are also suitable for buffer-strips, or for grass waterways where the drainage is good and the slope is not too severe. Species which form a sod or mat, or which establish quickly, are the most desirable. Consult Table 38 for characteristics of the plant species most commonly used for soil conservation.

FERTILIZERS FOR FORAGE CROPS

Nitrogen

Stands containing half or more legume do not require nitrogen fertilizers.

Grass stands containing less than one-third legume require large amounts of nitrogen. Where conditions permit, therefore, it is generally more profitable to reseed to mixtures containing legumes. It can be profitable, however, to fertilize grass stands consisting of productive species such as brome, orchard, or timothy. The use of nitrogen will also increase the protein level in the grass. The rates of nitrogen recommended for grass stands have been developed on the basis of the price of nitrogen relative to the value of hay (see Table 42). The first application for hay or pasture should be made as early as possible in the spring, followed by a second application after the first cutting and a third application after the second cutting. To avoid the danger of nitrate toxicity no more than 170 kg of N per ha should be applied at any one time.

Table 41. General Nitrogen Requirements-Perennial Forages

Crops	N Required kg/ha[1]
Legume or legume-grass at seeding — with or without companion crop	15
Unimproved pasture	50
Grass for seed	90
Hay or pasture — ½ or more legume	0
Hay or pasture — 1/3 to ½ legume	60
Hay or pasture — grass (less than 1/3 legume)	(See Table 42)

[1] *100 kg/ha = 90 lb/ac.*

Phosphate and Potash

Phosphate and potash requirements for forages are given in Tables 43 and 44. For information on use of these tables see *Fertilizer Recommendations* in *Soils Section*. When direct seeding on soils which require phosphate fertilizer, establishment may be improved by the placement of a high phosphate fertilizer 5 cm directly below the seed. Using a grain drill with fertilizer and grass seed attachments, this placement may be accomplished by drilling the fertilizer through the furrow opener and dropping the forage seed on a firm soil surface directly behind the furrow opener. Usually it is advisable to firm the soil surface immediately after seeding.

The timing of potash fertilizer application to established forage stands may influence the persistence of the stand. Potash, where required, is best applied prior to the fall rest period (see Figure 5). Phosphate, if required, may be applied with the potash in the fall or applied separately in the spring or summer.

Table 42. Nitrogen Requirement Table for Improved Grass Hay or Pasture

Value of Hay	Application No.[2]	Cost of Nitrogen Fertilizer — ¢/kg			
		60	70	80	90
$/tonne		N required[1] (kg/ha)			
30.00	1	95	75	70	70
	2	75	60	50	35
	3	60	50	40	30
50.00	1	130	125	115	105
	2	105	100	90	80
	3	85	80	70	65
70.00	1	150	140	135	130
	2	120	115	110	100
	3	95	90	85	80

100 kg/ha = 90 lb/ac.

[1] *For Stored Feed: where manure is applied, reduce the fertilizer application according to the type and amount of manure (see Manure section in Soils.*

For Pasture: all rates should be reduced by one third because of recycling through manure and urine.

[2] 1. *First application to be made prior to May 10.*
2. *Second application to be made after the first cut.*
3. *Third application to be made after the second cut only if there is reasonable assurance of a third cut.*

Table 43. Phosphate Requirements for Forages Based on OMAF Soil Tests

	At seeding with or without nurse crop		Forages at seeding-band seeded[1]		Established hay or pasture		Unimproved pasture	
Sodium Bicarbonate Phosphorus Soil Test (ppm)	**Rating**	**Phosphate (P_2O_5) Required[2] kg/ha**	**Rating**	**Phosphate (P_2O_5) Required[2] kg/ha**	**Rating**	**Phosphate (P_2O_5) Required[2] kg/ha**	**Rating**	**Phosphate (P_2O_5) Required[2] kg/ha**
0-3		130		130		90		70
4-5		110		110		70		60
6-7	LOW	90	LOW	90	LOW	60	LOW	50
8-9		70		70		50		30
10-12		50		50	MEDIUM	30		20
13-15		30	MEDIUM	40		20	MEDIUM	20
16-20	MEDIUM	20		30		0		0
21-25		20		20	HIGH	0		0
26-30		0	HIGH	20		0	HIGH	0
31-40	HIGH	0		20		0		0
41-50	VERY HIGH	0		20	VERY HIGH	0	VERY HIGH	0
51-60		0	VERY HIGH	0		0		0
61+	EXCESSIVE[3]	0	EXCESSIVE[3]	0	EXCESSIVE[3]	0	EXCESSIVE[3]	0

100 kg/ha = 90 lb/ac

[1] *For use only where seed is banded directly above the drilled fertilizer.*

[2] *Where manure is applied, reduce the fertilizer application according to the amount and quality of manure (see Manure Section in Soils.) Examples of fertilizer application: An established stand of hay containing over 50% alfalfa would require no nitrogen (see table 41). If it were not manured and the soil tests were 14 phosphorus and 110 for potassium, the phosphate requirement would be 20 kg/ha (from above table) and the potash requirement 70 kg/ha (Table 44). This could be supplied by broadcasting 45 kg/ha (20 ÷ 46 × 100) of 0-46-0 and 120 kg/ha (70 ÷ 60 × 100) of 0-0-60 prior to the fall rest period.*

[3] *Excessive readings may cause reduced yield or affect nutrient balance in crops and increase the risk of water pollution.*

Table 44. Potash Requirements for Forages Based on OMAF Soil Tests

	At Seeding with or without nurse crop		Fall applications for new seeding and established stands: Alfalfa[2]		Fall applications for new seeding and established stands: Other Forages	
Ammonium Acetate Potassium Soil Test (ppm)	**Rating**	**Potash (K_2O) Required[1] kg/ha**	**Rating**	**Potash (K_2O) Required[1] kg/ha**	**Rating**	**Potash (K_2O) Required[1] kg/ha**
0-15		90		480		250
16-30		80		400		220
31-45	LOW	70	LOW	320	LOW	190
46-60		50		250		160
61-80		40		200		120
81-100		30		120		90
101-120	MEDIUM	20		70	MEDIUM	70
121-150		20	MEDIUM	40		40
151-180	HIGH	0	HIGH	0	HIGH	0
181-250	VERY HIGH	0	VERY HIGH	0	VERY HIGH	0
251 +	EXCESSIVE[3]	0	EXCESSIVE[3]	0	EXCESSIVE[3]	0

100 kg/ha = 90 lb/ac

[1] *Where manure is applied, reduce the fertilizer according to the amount and quality of manure (see Manure section in Soils).*

[2] *Stand of 50% Alfalfa or more. Stands of less than 50% Alfalfa should be fertilized the same as other forages.*

[3] *Excessive ratings may cause reduced yield or quality of crops primarily due to magnesium deficiency. Natural levels above 251 occur occasionally on clay and clay loam soils, but are not expected to cause problems because soils naturally high in potassium are usually high in magnesium.*

Plant Analysis

For forage legumes, sample each species separately. The plant cut at normal mowing height at the late bud stage is recommended. However plants suspected of nutrient deficiency should be sampled as soon as the problem appears. Expert help will be required to interpret plant analysis results when the samples are not taken at the late bud stages.

A soil sample should be taken from the same area and at the same time as the plant sample.

For more information on plant analysis see *Plant Analysis* section in *Soils.*

Table 45. Interpretation of Plant Analysis for Alfalfa[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen (N)	%	—	5.5
Phosphorus (P)	%	0.20	0.5
Potassium (K)	%	1.7	3.5
Calcium (Ca)	%	—	4.0
Magnesium (Mg)	%	0.20	1.0
Sulphur (S)	%	0.22	—
Boron (B)	ppm	20	90
Copper (Cu)	ppm	5	30
Manganese (Mn)	ppm	20	100
Molybdenum (Mo)	ppm	0.5	5.0
Zinc (Zn)	ppm	10	70

[1] *Values apply to the plant cut at normal mowing height at the late bud stage.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Micronutrients

The micronutrient boron is particularly important for alfalfa. However, boron fertilizer applications are not required on all soils. Boron deficiency shows up mainly on high pH sandy soils. Boron applications are recommended on all sandy soils and in particular, the sandy loam and loam soils in the area east of the Niagara Escarpment to and including Frontenac County.

A shortage of available boron to the alfalfa plant first affects flowering and reduces seed-set. As the deficiency becomes more serious, the youngest upper leaves of the plant become yellow to red in color in different plants. Growth can be severely stunted and winter hardiness reduced.

Boron deficiency can usually be corrected or prevented by an application of 1.0 to 2.0 kg boron/hectare broadcast annually.

Boron should not be banded at seeding.

Mixtures of herbicides and fertilizers should not be applied to crop foliage unless recommended by competent authorities.

For further details on boron deficiency and on methods of application see OMAF Factsheet, *Boron Requirements of Alfalfa,* Agdex 121/531.

Manure

Manure is an excellent source of nutrients and can substitute for manufactured fertilizers. It is an excellent source of nitrogen for grasses but forage legumes do not make efficient use of manure nitrogen. Do not apply manure to perennial forage legumes when there is snow cover because ice frequently forms under the manure and can kill the plants (see *Manure* section in *Soils).*

Liming

Legumes generally are not tolerant of acid soil conditions. Acid soils should be limed one year before seeding, at rates indicated by soil tests.

DISEASE AND INSECT CONTROL IN FORAGE CROPS

(see also Pesticides section)

DISEASES

Verticillium Wilt of alfalfa now occurs on some farms in most areas of southern Ontario. This fungus disease causes death of alfalfa plants, mainly during the third and later production years. Where the disease is well established on the farm, second year stands can also be affected. Leaves on infected plants wilt, curl inward, and turn a tan brown colour. Growth is often considerably stunted and plants eventually die. The disease is spread from older infected stands to younger stands by harvest equipment, insects and manure.

The disease can be controlled by the use of resistant varieties. Consult Tables 28 and 29 for information on varieties with resistance to Verticillium wilt. For additional information, see OMAF Factsheet, *Verticillium Wilt of Alfalfa,* Agdex 121/600.

Leafspot diseases, Anthracnose of alfalfa: **Northern Anthracnose** of red clover. Timely harvesting of forage is important to reduce leaf loss and minimize disease in the regrowth. Clean harvest equipment of crop debris before using the equipment in the spring or when moving from field to field.

Phytophthora root rot is a soil-borne disease which can result in root injury or death of alfalfa plants. Young plants in new seedings are particularly prone to damage. The disease shows up in Ontario mainly on poorly drained soils or on clay loam soils during extended periods of wet weather. Consult Tables 28 and 29 for information on variety resistance to phytophthora root rot.

Other crown and root rots of alfalfa and red clover. Stresses such as leaf diseases, insects, frequent or untimely harvests, winter conditions and low soil pH increase severity of crown and root rots. Stresses during the growing season render the plants more susceptible to winter stress. Good crop management practices, especially a good harvesting schedule, and maintenance of adequate soil fertility and proper pH help to reduce disease severity. Control leafhoppers in alfalfa. Avoid mechanical injury of the crowns as much a possible. Crowns are easily injured by machinery and by livestock tramping, especially when the soil is wet.

INSECTS

Alfalfa Weevil Fungal disease and several species of parasites which help control the weevil are now established throughout Ontario and in most years forage stands do not warrant treatment with insecticides. However sporadic outbreaks will occur and farmers should check their fields carefully each year to detect threatening infestations. For more information on the alfalfa weevil, see OMAF Factsheet, *Alfalfa Weevil* Agdex 121/622. For early detection of damaging populations, see OMAF Factsheet, *Early Warning System for Alfalfa Weevil Management*, Agdex 121/622.

The larvae cause most of the damage. They hatch from eggs deposited in the stems and crawl to the tops of alfalfa where they feed on the developing leaf and flower buds. In heavy infestations, they shred the leaves so badly that fields take on a grayish-white or frosted appearance. Experience in Ontario has shown that the peak of larval attack coincides with the bud stage of the first crop. When threatening infestations occur, fields should be cut immediately to eliminate feeding damage. The bud stage is also the best time to cut the crop for maximum yield of protein.

The key to weevil control is proper timing of harvest and treatment based on field inspection. Examine each field twice a week from mid-May to June. Check several areas throughout the field. Look for damage to show up first on shallow soils or on southerly slopes.

1. **First Cut** If 25% of the stems have feeding damage in the tips, cut and remove from fields as soon as possible. If it is not possible to cut the crop immediately, treat with an insecticide as recommended in the following table.
2. **Second Cut** If damage was serious on first cut, feeding may continue and early regrowth should be carefully checked. If feeding retards regrowth, apply an insecticide.

Table 46. Alfalfa Weevil Control

Insecticide	Product per ha	Days to Cutting or Grazing
Furadan 480F*	285 mL	7
Imidan 50 WP	2.2 kg	7
Malathion 500 EC[1]	2-2.75 L	7

**Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*
EC (Emulsifiable Concentrate); F (Flowable);
WP (Wettable Powder)

[1] *Less effective below 16°C.*

CAUTION: See the warning PROTECT HONEYBEES in *Disease & Insect Control* in the Corn section. When planning to apply a pesticide, advise local beekeepers so that they have an opportunity to move colonies out of the danger area. Your local agricultural representative has a listing of the beekeepers in your area. Remember that bees are invaluable as pollinators for seed production and are commonly attracted in large numbers to flowering forage legumes.

Alfalfa Blotch Leafminer This pest of alfalfa is now present throughout Ontario. The adult leafminer is a small fly which emerges in late May. It is best identified by the numerous pinhole punctures it makes in alfalfa leaflets when it feeds and lays eggs. After the eggs hatch, the developing maggots feed inside the leaflet eating away the center part and producing mines or tunnels that terminate in blotches.

A species of parasite has controlled the alfalfa blotch leafminer across Ontario. Insecticides are generally not required and are not effective unless applied at the "pinhole" stage. If severe pinholing occurs and the crop can not be harvested early, the insecticide Imidan as listed in Table 46 may be used.

Potato Leafhopper The potato leafhopper causes a substantial loss in alfalfa yield and quality some years, particularly during dry seasons when plants are under stress. Damage to direct seedings may be severe. The first cut of established field escapes injury but as leafhoppers become more prevalent in late June to mid August, damage may be severe.

The potato leafhopper is a light green, wedge-shaped insect about 0.3 cm long when fully grown. The immature or nymph stage is yellowish-green and wingless but otherwise resembles the adult. Adult leafhoppers may jump or fly. Nymphs walk sideways or backwards to hide on the underside of the leaves.

This insect feeds by sucking plant juices. The alfalfa is stunted and the leaves turn yellow to bronze in color. A discolored V-shaped or triangular area often develops on the tips of leaflets. While this marking is characteristic of leafhopper presence, the leaf discoloration may also be a disease symptom or nutritional deficiency.

Effective control of the potato leafhopper depends on recognizing the adults and nymphs before symptoms become apparent. Check alfalfa fields frequently beginning in late June. See OMAF Factsheet, *Potato Leafhopper in Alfalfa*, Agdex 121/622. When leafhoppers are found, spray with the following.

Table 47. Leafhopper Control

Insecticide	Product per ha	Days to harvest
Cygon 480 E	425 mL	2

E (Emulsifiable Concentrate)

Alfalfa Snout Beetle. This potentially serious pest of forage crops has recently been discovered in eastern Ontario near Prescott. The adult is a flightless dark grey weevil, about 12 mm long. It emerges in early spring, feeds on alfalfa shoots and migrates into new fields to lay eggs. All the adults are female. The eggs hatch into white legless grubs which feed on the main and side roots of the host plant. The grubs girdle the tap root or gouge its surface leaving deep spiral grooves. The total life cycle requires a span of two years. Damage is most evident in late summer and early fall. Wilted plants should be dug and checked for damage and the presence of grubs. Alfalfa is the preferred host but the grubs also attack clover and a number of weeds. Infected alfalfa fields should be plowed under and planted to corn, soybeans or cereals for three years to reduce populations.

Until recently, the distribution was limited to northern New York State and a number of the St. Lawrence River Islands. If you suspect that you have this pest, consult your local OMAF office or Plant Health Division, Agriculture Canada, Ottawa.

Armyworm Maintain a close watch for outbreaks in grasses in late June and July. If they become destructive, control them as indicated in **Disease and Insect Control** in Cereal Crops section.

Cereal Leaf Beetle Refer to quarantine regulations under Insects, Cereal Crops section, concerning movement of hay.

European Skipper This is an occasional but important pest of timothy, both in hay and seed production. The adult is an orange butterfly with a 2.5 cm wing spread. It congregates in damp places and skips about hay fields in midsummer. The larvae are light green caterpillars up to 2.5 cm long, usually found within rolled leaves where they feed. Leaf margins become irregularly notched and when abundant they defoliate timothy. Fields must be checked for the caterpillars by late April or early May. Initially, the small caterpillars have black heads but soon become a brown color with two light bands. If six caterpillars in an area 30 cm × 30 cm are found as early as the brown-headed stage, treat the field or the infested area. Use either Thuricide HPC at 2.25 L/ha or Dipel at 0.3-0.6 kg/ha. Note that these insecticides will not immediately kill the caterpillars. However they will stop feeding.

Grasshoppers If grasshoppers become destructive, control them by spraying with an insecticide listed in Table 48.

Table 48. Grasshopper Control

Insecticide[1]	Product per ha	Days to Harvest
Basudin 50 W	1.1 kg	14
Diazinon 50 WP	1.1 kg	14
Malathion 25 WP	3.4 kg	7
500 EC	1.7 L	
*Guthion 240 SC	1.4 L	3

EC (Emulsifiable Concentrate); SC (Sprayable Concentrate); W (Wettable Powder); WP (Wettable Powder).

**Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*

WEED CONTROL IN FORAGES

For weed control recommendations see OMAF Publication 75, *Guide to Weed Control.*

BEFORE
USING
ANY PESTICIDE
STOP
READ THE LABEL
CAREFULLY

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre.

CERTIFIED
SEED
USE IT FOR ALL IT'S WORTH!

CEREAL CROPS

CROP MANAGEMENT

Grain crops deserve to be treated as first-rate crops whenever they are included in a cropping program. They must compete for their place in that program by producing high yields economically. To produce high yields requires that all parts of the grain production package be considered. No one factor can support high yields without the others. No one factor can be neglected without a corresponding decrease in yields.

Improved varieties express their full potential only when they are used in combination with proper seeding times, seeding depth, and recommended seeding rates as well as adequate fertility applications. Indeed, they perform well only when diseases, insects, and weeds are eliminated as production hazards.

Integrating the production practices into a package becomes the problem of the farmer. On his ability to do this rests the final yield and outcome of his grain production program.

Planting Date

Spring Grains

All spring grains respond to early seeding, because cool, moist conditions promote ample tillering and large heads. The target date should be April 10 for Southwestern Ontario, April 15 for Central and Eastern Ontario and May 10 for Northern Ontario. Planting delays much beyond the target date generally result in significant yield reduction.

Micmac, Rodeo and **Leger** barley and **Donald** and **Ogle** oats do not show as great a yield reduction with late planting as do other spring cereal varieties.

Birka barley and **Oxford** and OAC **Woodstock** oats are more adversely affected by planting delays.

Winter Grains

For good winter survival, seed early enough to obtain adequate top growth and root development in the autumn. For winter wheat grown in areas II and III this is between September 15-30 and two weeks later in area I. For winter barley seeding dates should be 1-2 weeks earlier than winter wheat.

Seeding Rate

Seeding rate recommendations are given in Table 49 and in the General Information section. The higher range of rates should be used (a) where emergence and early seed establishment is likely to be poor, eg. poor seed bed and aerial or broadcast seedings, and (b) for late planting where tillering will be reduced.

Seeding rate can be determined using the following formula:

$$\text{Seeding Rate (kg/ha)} = \frac{\text{plants/m}^2}{\text{\% germination}} \times \text{TKW}$$

For instance if you want 200 plants/m² of Leger barley (TKW-37) with a germination of 90% the seeding rate is 82 kg/ha (200 ÷ 90 × 37).

The thousand kernel weights (TKW) given in the tables are averages and may vary depending on the seed lot.

Table 49. Seeding Rate

Crop	Seeding Rates	
	Plants/m²	Plants[1]/ metre of row
Barley	200-400	35-70
Oats	165-330	30-60
Winter Wheat	240-400	45-70

[1] *For drills with 18 cm (7 inch) spacing.*

Lodging Control

For fields where lodging is expected, a plant growth regulator such as Cerone or Cycocel Extra may be used.

At present Cerone is registered for use on all spring barley varieties except Birka and all winter and spring wheat varieties. It should be applied at Zadoks' growth stages 37-45 (See Figure 6).

Cycocel Extra is registered on the hard red wheat varieties Monopol and Absolvent. It is applied at Zadoks' growth stages 23-31 (See Figure 6).

For information on rates and application procedure, consult the product labels.

Cereals for Soil Conservation

Winter rye has traditionally been used for seasonal and overwinter soil protection purposes but other common cereals can be used satisfactorily. Fast growing shoot and root growth, economical seed costs and competition to weeds are all factors in choosing a cereal species.

VARIETY SELECTION

Variety recommendations are general guides for choosing a variety. Descriptive tables accompanying recommendations show characteristics for each variety which may limit its use. Because no variety is perfect, the recommendations should be coupled with experience and information from the description to choose a variety for your use.

Yield data are included to indicate the relative yield performance of recommended varieties in each of the six testing areas in Ontario (See Figure 6).

Variety recommendations for grains to be stored and used as high moisture grains and whole plant silages are the same as those to be used for normal grain storage and use.

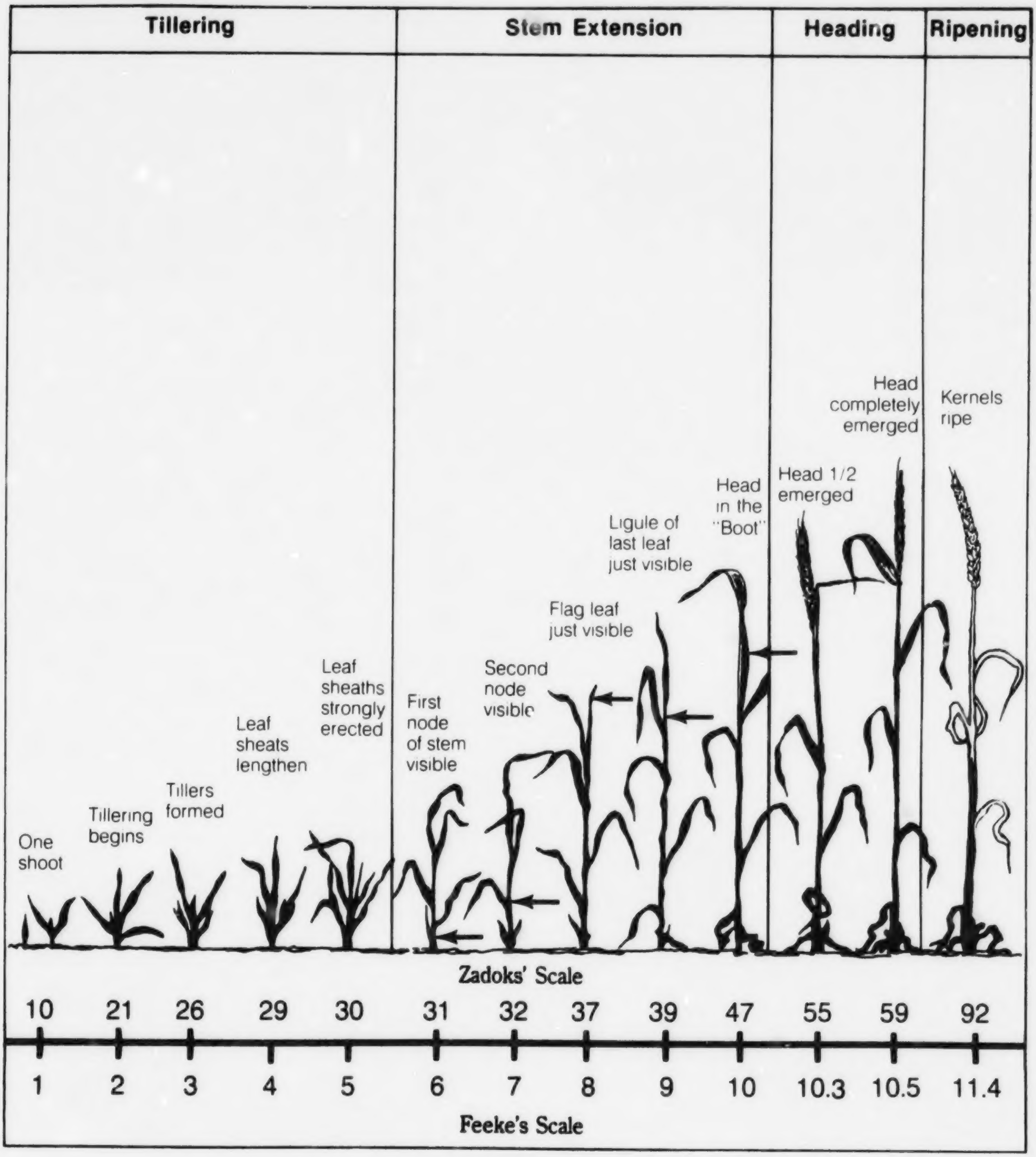
Tillering
Stem Extension
Heading
Ripening
One shoot
Tillering begins
Tillers formed
Leaf sheats lengthen
Leaf sheaths strongly erected
First node of stem visible
Second node visible
Flag leaf just visible
Ligule of last leaf just visible
Head in the "Boot"
Head 1/2 emerged
Head completely emerged
Kernels ripe
Zadoks' Scale
10
21
26
29
30
31
32
37
39
47
55
59
92
1
2
3
4
5
6
7
8
9
10
10.3
10.5
11.4
Feeke's Scale

Figure 6. Cereal Growth Stages

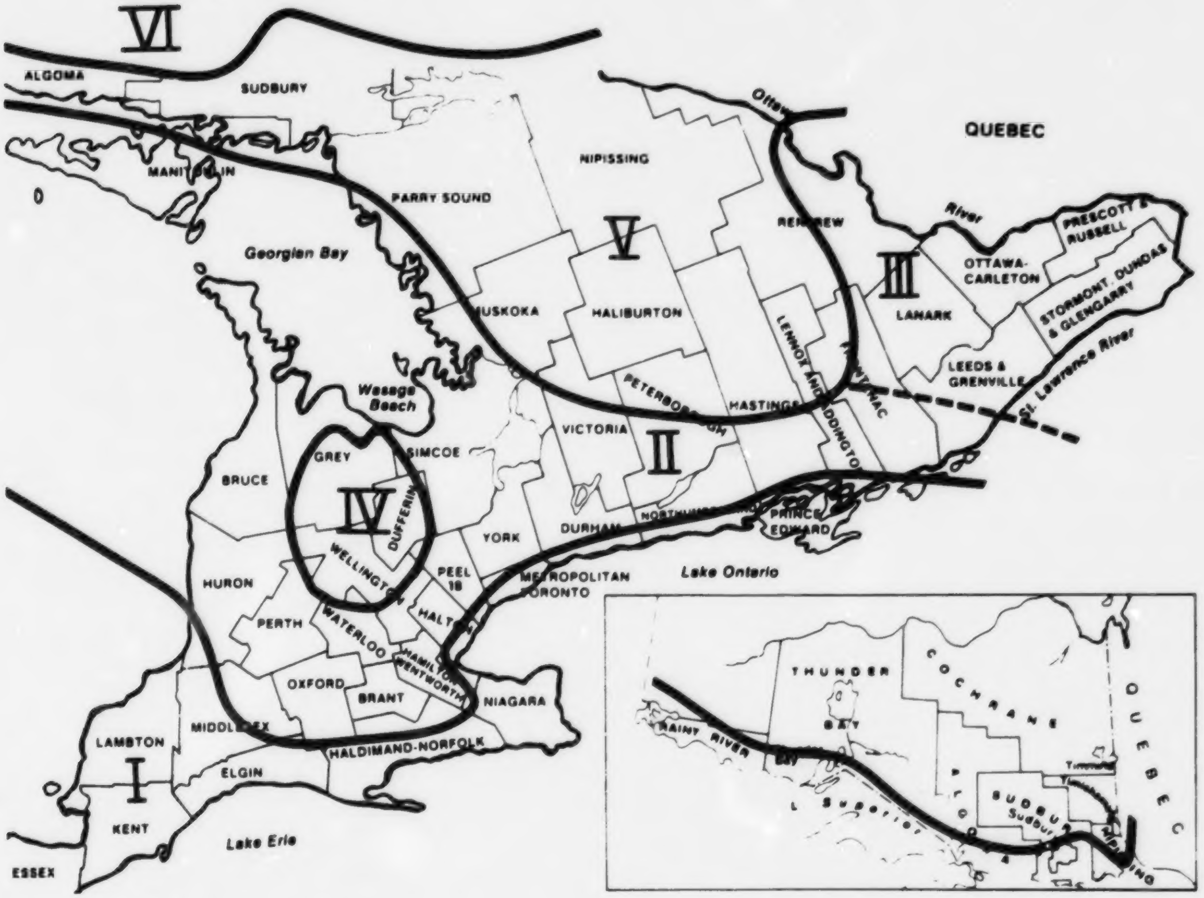
VI
ALGOMA
SUDBURY
QUEBEC
NIPISSING
MANITOULIN
PARRY SOUND
Ottawa
River
RENFREW
PRESCOTT & RUSSELL
Georgian Bay
V
III
OTTAWA-CARLETON
MUSKOKA
HALIBURTON
LANARK
STORMONT, DUNDAS & GLENGARRY
LENNOX AND ADDINGTON
FRONTENAC
LEEDS & GRENVILLE
St. Lawrence River
PETERBOROUGH
HASTINGS
Wasaga Beach
VICTORIA
GREY
SIMCOE
II
BRUCE
IV
DUFFERIN
NORTHUMBERLAND
PRINCE EDWARD
DURHAM
YORK
WELLINGTON
PEEL
METROPOLITAN TORONTO
Lake Ontario
HURON
HALTON
PERTH
WATERLOO
HAMILTON-WENTWORTH
OXFORD
BRANT
NIAGARA
LAMBTON
MIDDLESEX
HALDIMAND-NORFOLK
I
ELGIN
KENT
Lake Erie
ESSEX
THUNDER BAY
COCHRANE
QUEBEC
RAINY RIVER
ALGOMA
SUDBURY
L. Superior
NIPISSING

Figure 7. Cereal Crop Test Areas

SPRING GRAINS

Barley

Traditionally more six-rowed than two-rowed barley has been grown in Ontario. Adapted varieties of both types are available.

In general, two-rowed varieties are shorter, more resistant to lodging, larger seeded and more resistant to leaf rust and mildew than six-rowed barleys. Two-rowed barleys are, however, later in maturity than six-rowed barleys. Six-rowed varieties are usually more tolerant of heat and moisture stress and have better resistance to scald. The six-rowed varieties also tend to be more tolerant of late planting and are better for underseeding because of their less dense canopy.

There are virtually no differences between two-rowed barleys and six-rowed barleys in potential yield, however, there may be specific cultivar advantages in some areas (see Table 50).

The variety Leger, currently the most popular barley in Ontario, has become quite susceptible to mildew and has shown some sensitivity to atrazine residue. Occasionally it has been found as a problem volunteer in other crops the year following. This is a particular worry for seed growers.

New Varieties.

The 2-rowed varieties **Albany** and **Helena** and the 6-rowed variety **OAC Kippen** are now recommended. Albany and OAC Kippen are recommended in all areas whereas Helena is recommended in all areas except VI.

Table 50. Recommended Barley Varieties

							Diseases[4]				
Variety	Area Recommended	Type	Kernel weight (g/1000 seeds)	Height[1] (cm)	Lodging[2]	Maturity[3]	Leaf Rust	Loose Smut	Scald	Spot Blotch	Mildew
2-Rowed											
Albany	All	Rough-awned	42	67	3	95	5	3	8	8	1
Birka	All except VI	Rough-awned	41	66	2	97	3	3	5	8	0
Helena	All except VI	Rough-awned	41	66	2	95	5	3	8	8	0
Micmac	All except VI	Rough-awned	41	71	4	95	5	8	8	8	1
Rodeo	All	Rough-awned	41	68	2	95	5	3	8	8	0
6-Rowed											
Joly	All except I	Smooth-awned	37	74	4	95	8	5	5	8	2
Leger	All	Smooth-awned	37	78	3	95	8	1	5	8	7
Mingo	All except IV,VI	Smooth-awned	39	79	4	94	8	5	5	8	8
OAC Kippen	All	Rough-awned	37	79	3	94	7	6	5	5	0
Sophie[5]	V, VI	Smooth-awned	37	79	5	96	8	5	5	8	8

[1] *In general plants will be taller in the south and shorter in the north.*

[2] *Scale of 0-9 where 0 = standing and 9 = flat.*

[3] *Days to harvest. Subtract 5 days for areas I-IV and add 10 days for area VI.*

[4] *See Disease and Insect Control in Cereal Crops. Scale of 0-9 where 0 = very resistant and 9 = very susceptible.*

[5] *May be removed from the recommended list in 1990.*

Table 51. Relative Barley Yields[1,2]

	Test Areas					
Variety	I	II	III	IV	V	VI
	%					
Albany	107	97	103	100	97	97
Birka	105	94	95	100	97	86
Helena	100	100	105	100	97	89
Micmac	100	100	97	103	100	91
Rodeo	110	100	100	105	100	97
Joly	90	97	108	100	100	109
Leger	102	103	108	105	105	114
Mingo	102	103	100	97	103	106
OAC Kippen	98	106	103	108	108	100
Sophie	93	90	90	92	100	100
Average yield[3] (t/ha)	4.1	3.1	3.9	3.7	3.7	3.5

[1] *Expressed as a percentage of the average yield of listed varieties in each area.*

[2] *Two year average (1987-88).*

[3] *1 t/ha = 893 lb/ac.*

Oats

Oats are a traditional feed crop in Ontario, particularly for horses. Oats have a higher fiber content and a better balanced protein in comparison to barley. In Eastern Ontario where buckthorn is common, leaf rust is a problem in oat production and resistant varieties should be grown.

The leaf rust resistance of OAC Woodstock has broken down and this variety should no longer be considered resistant in Eastern Ontario.

Milling Oats

Milling oats have to meet special quality requirements: plump kernels, high hectoliter weight and groats that are free of discoloration. **Donald, Marion, OAC Woodstock** and **Ogle** are preferred for milling purposes.

Table 52. Recommended Oat Varieties

							Diseases[4]			
Variety	Area Recommended	Type	Kernel Weight (g/1000 seeds)	Height[1] (cm)	Lodging[2]	Maturity[3]	Leaf Rust	Barley Yellow Dwarf	Septoria	Smut
Baldwin	All	white	34	98	4	98	8	8	8	5
Donald	All	white	33	86	3	96	8	5	8	1
Dumont	III, V, VI	white	33	87	5	99	1	8	8	1
Marion	All	white	36	94	3	98	8	8	8	5
OAC Woodstock	All	white	32	92	3	98	8[5]	8	5	1
Ogle	All	yellow	31	77	1	94	5	3	3	5
Oxford	All	yellow	31	86	2	99	5	5	3	1

Values are given to indicate relative differences between varieties; actual values will differ depending on growing conditions and disease pressures.

[1] *In general plants will be taller in the south and shorter in the north.*

[2] *Scale of 0-9 where 0 = standing and 9 = flat.*

[3] *Days to harvest. Subtract 5 days for areas I-IV and add 10 days for area VI.*

[4] *See Disease and Insect Control in Cereal Crops. Scale of 0-9 where 0 = very resistant and 9 = very susceptible.*

[5] *OAC Woodstock is attacked by prevalent rust strains in Eastern Ontario.*

Table 53. Relative Oat Yields[1,2]

	Test Areas					
Variety	I	II	III	IV	V	VI
			%			
Baldwin	97	104	109	106	103	109
Donald	106	96	97	92	97	97
Dumont	94	93	97	94	91	94
Marion	114	107	109	103	111	103
OAC Woodstock	89	96	97	103	97	97
Ogle	103	107	100	97	100	91
Oxford	94	93	100	100	100	100
Average yield[3] (t/ha)	3.6	2.8	3.4	3.6	3.5	3.5

[1] *Expressed as a percentage of the average yield of listed varieties in each area.*

[2] *Two year average (1987-1988).*

[3] *1 t/ha = 893 lb/ac.*

Hulless Oats

Hulless oats may be of interest to pig and poultry producers because the grain (groat) is approximately the same metabolizable energy content as corn. Combined with this is a high protein content (14-20%), depending on soil fertility, of good quality for cereal grain. Diets can be formulated with hulless oats as a major energy source and only small amounts of soybean meal, canola meal or the amino acid lysine need to be added to obtain performance comparable to a standard corn-soybean meal diet.

Hulless oats become groats when they are threshed. The thin hulls are left in the field as chaff, resulting in a weight loss of 25-30% compared to regular varieties where the hull is retained.

Tibor is a tall oat, very strong strawed, large-seeded, high test weight, moderately high protein and smut resistant. It is susceptible to barley yellow dwarf virus and crown rust but rust is slow to develop in field scale plantings.

The performance of Tibor was determined in the Ontario Regional Trials over a two year period (1987-1988). Provincially, groat yield for Tibor was 2.4 tonnes/ha compared to the calculated groat yields of the varieties Baldwin (2.4), Donald (2.2), Dumont (2.2), Marion (2.5), OAC Woodstock (2.2), Ogle (2.3) and Oxford (2.3).

Tibor can be grown like regular oats but special attention must be paid to planting, harvesting, handling and storage of seed to be fully successful.

For further information contact your local OMAF office.

Mixed Grains

Mixed grains occupy a large hectareage in the province. No specific recommendations regarding the best mixtures can be made. Generally the highest yielding varieties of oats and barley in pure stands also perform best in mixtures.

Height and maturity ratings of the components of a mixture must be matched. For example, Donald oats match well with Leger or Rodeo barley, and Ogle oats match well with Birka or Leger barley.

An advantage of mixed grains is that leaf and head diseases usually are much less severe than where oats or barley are grown alone.

Spring Wheat

Feed Wheat

In areas III, IV, V and VI some varieties can be competitive with oats and barley as feed grain. For those farmers who choose to grow spring wheat for feed the following varieties are available.

Glenlea — awnless, white chaff and large red grain. Utility type wheat not equal in quality to hard red spring types.

Milling Wheat

To ensure a market, care must be taken to grow a quality product. This includes such factors as early planting and control of weeds which may be a problem in Western Canadian varieties, with their more open canopy as compared to barley.

Columbus — A Western Canadian hard red wheat. It has a medium to good straw, is susceptible to mildew and moderately resistant to leaf rust. It has good to excellent sprouting resistance.

Katepwa — A Western Canadian hard red wheat. It has a medium straw, and is susceptible to mildew and moderately resistant to leaf rust. It is somewhat earlier than Columbus.

Max — A German hard red wheat. It has medium straw strength and is resistant to mildew but susceptible to leaf rust.

Roblin — A Western Canadian hard red wheat. It has a good straw and is susceptible to mildew and moderately resistant to leaf rust. It is somewhat earlier than Columbus.

WINTER GRAINS

Winter Wheat

Two very different types of winter wheat are now grown in Ontario — soft white and hard red. Each has very different quality requirements. Because of this, the two types should be kept separate throughout the production and marketing channels. Mixed lots will only find a use as livestock feed, and will realize a lower price than unmixed lots of wheat of milling grade.

Soft White Winter Wheat

Soft white winter wheat has long been the dominant winter grain of Ontario. Markets are well established, and varieties well adapted to Ontario conditions are available (Table 54).

Hard Red Winter Wheat

Hard red winter wheat is now grown in Ontario. Available varieties include Absolvent and Monopol.

Absolvent — Not as strong-strawed as Monopol, but it is earlier. Susceptible to mildew.

Monopol — A strong-strawed variety, it is susceptible to mildew and late maturing.

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Table 54. Recommended Soft White Winter Wheat Varieties

							Diseases		
Variety	Area Recommended	Kernel Weight	Awns	Height	Sprouting Resistance	Lodging[1]	Leaf Rust[2]	Scab[3]	Mildew[2]
Augusta	I, II, III	36	–	97	Medium	1.2	3.7	29	3.4
Frankenmuth	I[4], II[4]	36	–	96	Medium	1.5	4.6	33	2.7
Fredrick	I[4]	36	–	100	Medium to Good	1.2	3.6	14	2.9
Harus	I, II	37	–	91	Medium to Good	.8	4.1	10	2.0
Houser	I[5], II[5], III[5]	38	+	90	Poor	1.8	4.4	18	2.3

Winter survival is similar for all varities.

All varieties should be seed treated to control loose smut.

Values are given to indicate relative differences between varieties; actual values will differ depending on growing conditions and disease pressure.

[1] *Scale of 0 - 9 where 0 = standing and 9 = flat.*

[2] *Scale of 0 - 9 where 0 = very resistant and 9 = very susceptible.*

[3] *Number of plants infected per 1000.*

[4] *Only where test weight is a problem with other varieties.*

[5] *Not on light, droughty soils and other locations where test weight is a problem.*

Table 55. Relative White Winter Wheat Yields[1,2]

Variety	I	II	III
		Test Areas	
		%	
Augusta	105	103	106
Frankenmuth	98	99	99
Fredrick	95	95	93
Harus	102	101	98
Houser	100	102	104
Average Yield (t/ha)[3]	4.5	4.9	5.1

[1] Expressed as a percentage of the average yield of listed varieties in each area.

[2] Four year average (1985-1988).

[3] 1 t/ha = 893 lb/ac.

Table 56. Relative White Winter Wheat Test Weights[1,2]

Variety	I	II	III
		Test Areas	
		%	
Augusta	98	99	99
Frankenmuth	101	101	100
Fredrick	102	102	103
Harus	101	101	101
Houser	96	97	97
Average test weight (kg/hL)[3]	74	75	80

[1] Expressed as a percentage of the average test weight of listed varieties in each area.

[2] Four year average (1985-1988).

[3] kg/ha × .801 = lb/bu.

Winter Barley

Winter barley has higher yield than spring barley but is considerably less winterhardy than winter wheat. It can be expected to survive only in areas I and II with adequate snow cover. Winter barley matures much earlier than winter wheat and if harvested as a silage crop is suitable for double cropping.

OAC Acton is a six-rowed, rough-awned cultivar with rust and lodging resistance similar to OAC Halton. It has longer straw, higher yield, better scald resistance and barley yellow dwarf tolerance than OAC Halton but is susceptible to current races of mildew.

OAC Elmira is a new six-rowed, rough-awned cultivar. It has similar winter hardiness to the other winter barleys but higher yield combined with better lodging, scald and mildew resistance. It has much better barley yellow dwarf virus resistance than other winter barleys.

OAC Halton is a six-rowed, rough-awned cultivar with short straw and good lodging resistance. It is resistant to leaf rust and mildew but susceptible to scald in most areas.

Winter Triticale

OAC Wintri has better winter survival compared to recommended winter wheat varieties, but is very tall and late maturing. It has poor lodging resistance, especially on heavier soils.

OAC Decade and **OAC Trillium** are much shorter than OAC Wintri and have improved lodging resistance.

Table 57. Distributors for Cereal Grain Varieties

	Variety	Distributor[1]	Breeder
Barley	Albany	SeCan Members	Charlottetown Res. Station
	Birka	W.G. Thompson & Sons Ltd.	Weibull's, Sweden
	Joly	King Agro	Semico, St. Hyacinthe
	Helena	King Agro	Dr. J. Ackerman, Germany
	Leger	SeCan Members	Plant Res. Centre, Ottawa
	Micmac	SeCan Members	Charlottetown Res. Station
	Mingo	W.G. Thompson & Sons Ltd.	Ciba-Geigy, Ailsa Craig
	OAC Kippen	SeCan Members	OAC, Guelph
	Rodeo	W.G. Thompson & Sons Ltd.	Ciba-Geigy, Ailsa Craig
	Sophie	Jean Labonte et Fils Inc.	U. Laval, Ste. Foy Res. Station
Oats	Baldwin	SeCan Members	Macdonald College
	Donald	SeCan Members	Plant Res. Centre, Ottawa
	Dumont	SeCan Members	Winnipeg Res. Station
	OAC Woodstock	SeCan Members	OAC, Guelph
	Ogle	Public	U. of Illinois
	Oxford	W.G. Thompson & Sons Ltd.	OAC, Guelph
	Tibor	W.G. Thompson & Sons Ltd.	Plant Res. Centre, Ottawa
Spring Triticale	OAC Triwell	King Agro	OAC, Guelph
Spring Wheat Feed			
Feed	Glenlea	Public	Univ. of Manitoba
Milling	Columbus	SeCan Members	Winnipeg Res. Station

(Continued on Page 56)

Table 57. Distributors for Cereal Grain Varieties (con't)

	Variety	Distributor[1]	Breeder
	Katepwa	SeCan Members	Winnipeg Res. Station
	Max	C & M Seeds, Aishling Farm Seeds	Dr. Hegge, Germany
	Roblin	SeCan Members	Winnipeg Res. Station
Winter Barley	OAC Acton	King Agro	OAC, Guelph
	OAC Elmira	W.G. Thompson & Sons Ltd.	OAC, Guelph
	OAC Halton	SeCan Members	OAC, Guelph
Winter Rye	Danko	King Agro	Polish Plant Breeding Institute
Winter Triticale	OAC Decade	King Agro	OAC, Guelph
	OAC Trillium	SeCan Members	OAC, Guelph
	OAC Wintri	King Agro	OAC, Guelph
Winter Wheat			
Soft White	Augusta	W.G. Thompson & Sons Ltd.	Michigan State Univ.
	Frankenmuth	King Agro	Michigan State Univ.
	Fredrick	Public	Plant Res. Centre, Ottawa
	Harus	SeCan Members	Harrow Res. Station
	Houser	W.G. Thompson & Sons Ltd.	Cornell Univ.
Hard Red	Absolvent	C & M Seeds, Aishling Farm Seeds	Dr. P. Franck, Germany
	Monopol	C & M Seeds, Aishling Farm Seeds	Baywa, Germany

[1] *See Distributor Addresses in General Section.*

FERTILIZERS FOR CEREAL CROPS

Nitrogen

Nitrogen fertilizer recommendations for cereal crops are given in Tables 58 and 59. High rates of nitrogen from manures or manufactured fertilizers can cause lodging of cereals.

Table 58. Nitrogen Requirements — Cereal Crops

Crops	N required[1] kg/ha
Barley (areas receiving 2600 heat units or less)	70
Barley (areas receiving more than 2600 heat units)	45
Cereals seeded as a nurse crop for forages	15
Mixed grain, spring triticale (southern Ontario)	45
Mixed grain, spring triticale (northern Ontario)	70
Oats, spring rye (southern Ontario)	35
Oats, spring rye (northern Ontario)[2]	55
Spring wheat[2]	70
Winter barley, winter rye	90[3]
Winter triticale	80[3]
Winter wheat	See Table 59

100 kg/ha = 90 lb/ac.

[1] *Where manure is applied or the preceding crop is a legume sod, reduce the nitrogen rates as shown in Tables 4 and 5.*

[2] *This is an interim recommendation based on limited research.*

[3] *When not in rotation with tobacco.*

Table 59. Nitrogen Requirements for Soft White Winter Wheat[1]

Cost of Nitrogen Fertilizer	Expected Yield[2] — t/ha		
	3.5	4.5	5.5
$/kg	Most Profitable Nitrogen Application[3] — kg/ha		
.50	80	90	110
.60[4]	75	85[5]	110
.70	70	85	105

100 kg/ha = 90 lb/ac.

[1] *Nitrogen requirements are based on winter wheat valued at $142/tonne.*

[2] *Expected yield is that yield which you, in your experience, should obtain under your conditions of soil, climate and management.*

[3] *When not in rotation with tobacco.*

[4] *The highlighted area represents the most appropriate ratio at time of printing.*

[5] *If your expected yield is 4.5 t/ha and nitrogen costs $.65/kg, then 85 kg/ha of nitrogen is the most profitable rate of application.*

BEFORE
USING
ANY PESTICIDE
STOP
READ THE LABEL
CAREFULLY

Table 60. Phosphate Requirements for Cereals Based on OMAF Soil Tests

	Spring barley, spring wheat, and mixed grain		Oats, spring triticale, and spring rye		Winter wheat, W. rye, W. barley, W. triticale		Winter or spring grains seeded down	
Sodium Bicarbonate Phosphorus Soil Test (ppm)	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Rating	Phosphate (P_2O_5)[1] Required kg/ha
0-3		110		70		70		130
4-5		100		60		60		110
6-7	LOW	90	LOW	50	LOW	50	LOW	90
8-9		70		30		30		70
10-12		50		20		20		50
13-15	MEDIUM	20	MEDIUM	20	MEDIUM	20	MEDIUM	30
16-20		20		0		20		20
21-25		0	HIGH	0		0		20
26-30	HIGH	0		0	HIGH	0		0
31-40		0		0		0	HIGH	0
41-50	VERY HIGH	0	VERY HIGH	0		0		0
51-60		0		0	VERY HIGH	0	VERY HIGH	0
61+	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac.

[1] *Where manure is applied reduce the fertilizer application according to the amount and quantity of manure (see Manure Section in Soils). For spring barley in an area with less than 2600 heat units, not manured and not following a legume sod, the nitrogen requirement is 70 kg/ha (see Table 58). If the soil tests are 11 for phosphate and 48 for potash, the phosphate requirement would be 50 kg/ha and the potash requirement 50 kg/ha. These nutrients could be supplied by drilling 250 kg (50 ÷ 20 × 100) of 5-20-20 per hectare to supply the phosphate and potash and broadcasting 170 kg of 34-0-0 or 130 kg of 45-0-0 per hectare to supply the recommended amount of nitrogen.*

[2] *Excessive readings may cause reduced yield or affect nutrient balance in crops and increase the risk of water pollution.*

Table 61. Potash Requirements for Cereals Based on OMAF Soil Tests

	Spring barley, spring wheat, and mixed grain		Oats, spring triticale, and spring rye		Winter wheat, W. rye, W. barley, W. triticale with or without seeding down		Spring cereals seeded down	
Ammonium Acetate Potassium Soil Test (ppm)	**Rating**	**Potash (K_2O)[1] Required kg/ha**	**Rating**	**Potash (K_2O)[1] Required kg/ha**	**Rating**	**Potash (K_2O)[1] Required kg/ha**	**Rating**	**Potash (K_2O)[1] Required kg/ha**
0-15		90		70		50		90
16-30		80		50		40		80
31-45	LOW	70	LOW	40	LOW	30	LOW	70
46-60		50		30		20		50
61-80		40	MEDIUM	20		20		40
81-100		30		20	MEDIUM	20		30
101-120	MEDIUM	20	HIGH	0	HIGH	0	MEDIUM	20
121-150		20		0		0		20
151-180	HIGH	0		0		0	HIGH	0
181-210		0	VERY HIGH	0	VERY HIGH	0		0
211-250	VERY HIGH	0		0		0	VERY HIGH	0
251+	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac.

[1] *Where manure is applied reduce the fertilizer application according to the amount and quantity of manure (see Manure section in Soils).*

[2] *Excessive ratings may cause reduced yield or quality of crops primarily due to magnesium deficiency. Natural levels above 250 occur occasionally on clay and clay loam soils but are not expected to cause problems because soils naturally high in potassium are usually high in magnesium.*

Plant Analysis

For cereals, sampling the top two leaves at heading is recommended. However, plants suspected of nutrient deficiency should be sampled as soon as the problem appears. For plants less than 20 cm tall, sample the total above ground plant. Expert help will be required to interpret plant analysis results when the samples are not taken at heading.

A soil sample should be taken from the same area and at the same time as a plant sample.

For more information on plant analysis see *Plant Analysis* section in *Soils*.

Micronutrients

Manganese deficiency occurs occasionally on cereals in Ontario. Copper deficiency may occur on organic soils and is suspected in rare occasions on very sandy soils. Boron deficiency has not been diagnosed on cereals and boron applications can be toxic. Zinc deficiency on cereals does not appear to be a problem.

Manganese deficiency frequently occurs when wheat, oats or barley are grown on an organic soil. It can occasionally occur on mineral soils high in organic matter and on very sandy soils. On oats, manganese deficiency appears as irregular oval gray spots on the leaves. On barley and wheat, it appears more commonly as a light yellow color on the leaves with the veins in the leaf remaining slightly darker green. In addition to deficiency symptoms on leaves, both soil tests and plant analyses are useful in predicting where manganese deficiences are likely to occur. Both are available at the OMAF soil testing and plant analysis laboratory. Correct the deficiency as soon as detected by spraying the foliage with 2 kg manganese/ha from manganese sulfate (8 kg manganese sulfate/ha) in 200 L of water.

Table 62. Interpretation of Plant Analysis for Cereal Crops[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen (N)	%	2.0	2.7
Phosphorus (P)	%	0.1	0.5
Potassium (K)	%	1.0	3.0
Calcium (Ca)	%	—	1.0
Magnesium (Mg)	%	0.15	1.0
Boron (B)	ppm	3	40
Copper (Cu)	ppm	3	50
Manganese (Mn)	ppm	15	200
Zinc (Zn)	ppm	10	70

[1] *Values apply to the top two leaves sampled at heading.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

A "spreader-sticker" in the spray is recommended for materials other than chelates. If the deficiency is severe, a second spray may be beneficial.

Soil application is not a recommended way to apply manganese regardless of source because of the large amounts required.

Application of manganese chelates to the soil has resulted in yield reductions.

Mixtures of herbicides and foliar fertilizers should not be applied to crop foliage unless recommended by competent authorities.

For further details on manganese deficiencies and on methods of application, refer to OMAF Factsheet, *Manganese in Soybeans and Small Grain Production*, Agdex 100/531.

DISEASE AND INSECT CONTROL IN CEREAL CROPS

(see also Pesticides section)

Seed Treatment

Following cleaning, all cereal should be treated with a seed treatment. Good coverage of the seed is essential. Follow the precautions under *Seed Treatments in General Information on Pesticide Usage* section, when applying any chemical seed treatment.

Seed treatments control certain soil and seed-borne cereal diseases. The recommended seed treatments and diseases controlled are given in Table 63.

Table 63. Cereal Seed Treatments

			Diseases									
			Oats		Barley			Wheat				Rye
Product	**Active Ingredient**	**Formulation[2]**	Covered Smut	Loose Smut	Covered Smut	Loose Smut	Seedling Blight	Common Bunt	Soil Borne Dwarf Bunt	Loose Smut	Seedling Blight	Seedling Blight
Agrox N-M	maneb	P (DB)	+	+	+	–	–	+	–	–	+	+
Agrox flowable	maneb	F	+	+	+	–	–	+	–	–	+	+
[1]Anchor	carbathiin + thiram	F (DB)	+	+	+	+	+	+	–	+	+	+
Busan 30	TCMTB	EC	+	+	+	–	–	+	–	–	+	+
Co-op N M	maneb	P (DB)	+	+	+	–	–	+	–	–	+	+
[1]Vitaflo-250	carbathiin	F	+	+	+	+	–	+	–	+	–	–
[1]Vitaflo-280	carbathiin + thiram	F	+	+	+	+	+	+	–	+	+	+
[1]Vitavax Powder	carbathiin + thiram	P (DB)	+	+	+	+	+	+	–	+	+	+
Seed Treatments With Insecticides												
Mergamma N-M	maneb + lindane	P (DB)	+	+	+	–	–	+	–	–	+	+
Co-op N M Dual Purpose	maneb + lindane	P (DB)	+	+	+	–	–	+	–	–	+	+
[1]Vitaflo Dual Purpose	carbathiin + thiram + lindane	F	+	+	+	+	+	+	–	+	+	+
Vitavax Dual Powder	carbathiin + thiram + lindane	P (DB)	+	+	+	+	+	+	–	+	+	+

[1] *Read the paragraph on seed treatments, and also the sections Loose Smut of Barley, Loose Smut of Wheat.*

[2] *EC (Emulsifiable Concentrate); P (Powder); F (Flowable); DB (Drill Box Application).*

+ Recommended for disease listed.

– NOT recommended.

Table 64. Foliar Disease Control in Wheat[1]

			Diseases					
Fungicide	**Product/ha**	**Days to Harvest**	Septoria Glume Blotch	Septoria Leaf Spot	Rust — Leaf	Rust — Stem	Powdery Mildew	Tan Spot
*Bayleton 50WP	250-550 g	60	–	–	+	+	+	–
Dithane M45	2.25 kg	40	+	+	+	–	–	+
Tilt 250E[1]	500 mL	45	+	+	+	+	+	+

WP (Wettable Powder); E (Emulsifiable Concentrate).

+ Recommended for diseases listed.

– NOT recommended.

**Temporary Registration (Restricted). For more information see Federal Registration and Provincial Classification, inside front cover.*

Bayleton 50 WP is classified in Ontario for use only on hard red and soft white winter wheat. A Provincial Permit is required.

[1] *Tilt is also classified for use on spring barley, for control of powdery mildew, rust and leaf spot diseases.*

DISEASES

See OMAF Factsheets, *Leaf and Head Diseases of Barley*, Agdex 114/632; *Leaf Diseases of Winter Wheat*, Agdex 112/600; *Head Diseases of Winter Wheat*, Agdex 112/630; *Yellow Dwarf of Cereals*, Agdex 110/632; *Root, crown and basal stem diseases of winter wheat*, Agdex 112/630.

Diseases Affecting Wheat, Barley and Oats

Powdery mildew is favored by warm, humid weather. White powdery growth of the mildew fungus appears on the foliage and sometimes on the heads. Wheat, barley and oats are each attacked by different strains of the fungus. In areas prone to severe mildew, use the more resistant varieties of winter wheat (Table 54) or resistant varieties of barley (Table 50). Also see Table 64 for control with fungicides.

Ergot occurs from time to time on barley and triticale. Exercise caution in feeding grain containing the black ergot bodies to livestock, especially swine. Do not sow seed containing ergot. Consult Agriculture Canada Publication 1438, *Ergot of Grains and Grasses.*

Barley Yellow Dwarf or Oat Red Leaf. This disease was unusually severe in 1959 and 1976. It is unlikely to be severe unless warm weather and southerly winds occur in April. Direct control by spraying the aphids which carry the virus is unlikely to be useful. Early seeding is an advantage in spring grains. Winter wheat also is susceptible to barley yellow dwarf. Late planting helps to avoid infection in the fall. See OMAF Factsheet, *Yellow Dwarf of Cereals*, Agdex 110/632.

Wheat Diseases

Loose Smut. Sow pedigreed seed. Vitaflo-280 which contains carbathiin for smut control and thiram for control of seedling blight is recommended for wheat grown for food or feed. All wheat grown for seed should be treated with Vitaflo-250 or the higher rate of Vitaflo-280 for effective smut control.

Dwarf bunt occurs on winter wheat primarily in counties bordering Georgian Bay and Lake Huron where snow cover is deep and persistent in late winter and early spring. The bunt fungus survives for many years in the soil and can also be seed-borne. Treatment of infested seed with a seed treatment containing carbathiin will control dwarf bunt on the seed. None of the registered seed treatments will control soil-borne dwarf bunt.

Fusarium seedling blight can be carried on seed or in crop debris. The fungus causes poor germination and reduced plant stands. If the seed treatment already applied does not contain maneb or thiram, a seed treatment containing maneb or thiram should be added. See Table 63.

Fusarium Head Blight (Scab) outbreaks occur when the weather is warm and wet at the flowering to soft-dough stages. Vomitoxin may be present in diseased heads. See OMAF Factsheets, *Head Diseases of Winter Wheat*, Agdex 112/630 and *Moldy Feeds and Swine Diseases*, Agdex 440/660. Head blight is usually more severe when wheat follows wheat, corn or triticale. Plow down infested stubble and straw.

Eyespot, Strawbreaker and Take All are often damaging, especially when wheat follows wheat. Avoid early planting. Clean plowing helps to reduce eyespot severity. Include crops such as soybeans, field beans, canola, clovers, alfalfa or oats in the rotation.

Septoria leaf spot is most severe at the heading stage but also develops under snow cover. Irregular brown spots, often speckled with black fungal bodies, appear on the leaves. No symptoms appear on the heads. Wet, windy weather and moderate temperatures are favorable to disease development.

Septoria glume blotch develops mainly after the heads emerge. Oval brown spots appear on the leaves and purplish-brown areas appear on the head. The affected areas are often speckled with tiny brown fungal bodies. Wet, windy weather and warm temperatures favor the disease. Rotation with crops other than cereals and plowing down of cereal residues help to control glume blotch. Treat seeds with a recommended fungicide. See Table 64 for control with fungicides.

Leaf rust is often widespread, especially after wheat heads emerge. The rust fungus appears to overwinter on winter wheat and may also be blown from the U.S.A. Information on resistance of wheat varieties from leaf rust is given in Table 54. See also Table 64 for control with fungicides.

Stem rust may be serious in wheat grown near common barberry. The common barberry is the source of the rust fungus and should be destroyed. Contact your Area Weed Inspector or Ministry of Agriculture and Food office for assistance in identification and control. Consult OMAF Publication 49, *Rid Ontario of Common Barberry and European Buckthorn.* See Table 64.

Snow Mold. In years when snow mold causes great reduction in winter wheat stands, reseed as soon as possible with a spring grain. This disease does not affect spring-planted grain.

Barley Diseases

Loose Smut. Sow pedigreed seed of a resistant barley variety. However, these varieties are resistant ONLY to the prevalent races of smut fungus and may not resist other races. It is **strongly recommended** that **all barley seed be treated with Vitaflo-280** or a drillbox formulation containing carbathiin.

Spot Blotch, Seedling Blight, Root Rot and Head Blight are often serious and widespread and are caused by the same fungus. The fungus overwinters in seed, barley debris and soil. All barley seed should be treated with the fungicide Vitaflo-280 to control the fungus inside the seed and that which invades seedlings from the soil. To reduce severity of spot blotch and head blight, avoid growing barley after barley, wheat and grasses. Early planting helps to avoid serious disease in July. Disease is less severe on barley grown in mixture with oats.

Net Blotch and Scald especially occur in cool, humid seasons. Two-rowed barleys usually are more susceptible to net blotch and scald than are 6-rowed barleys. To help prevent buildup of these diseases, avoid growing barley after barley, plow down stubble and straw as completely as possible, and treat seed with a fungicide containing carbathiin or maneb (Table 63).

Also see Table 64 for control with fungicides.

Oat Diseases

Septoria Leaf Blotch in oats can cause severe damage in all recommended varieties. The disease is recognized by the appearance of mottled, light and dark brown, elongated blotches on the leaf blade, extending to the leaf sheath and culm. Advanced stages on the culm turn black and the weakened culm breaks over easily resulting in damage due to lodging. Avoid planting oats after oats or mixed grains.

Oat Leaf Rust is often serious, especially in Central and Eastern Ontario. European buckthorn is the source of the rust fungus. This shrub is described in OMAF Publication 49, *Rid Ontario of Common Barberry and European Buckthorn.* Information on resistance of oat varieties to leaf rust is given in Table 52.

Oat Cyst Nematode. Damage by the oat cyst nematode is first noticed about two or three weeks after oat plants emerge, at which time heavily infected plants appear to suddenly stop growing, leaves turn pale in color and begin to die back from the tips downward. These plants fail to tiller resulting in a thin stand of stunted plants which produce little grain. Below ground the root systems are severely stunted and usually discolored, from a pale-yellow in early growth to a yellow-brown in mature plants, as compared to the clear white in healthy plants.

To confirm suspected oat cyst nematode damage, send a sample of several plants with adhering soil to the Pest Diagnostic Clinic, Department of Environmental Biology, University of Guelph, Ontario, N1G 2W1 for diagnosis.

If oat cyst nematodes have caused damage, do not plant spring grains the following year. Use legume or row crops in the rotation. Corn can be used if the nematode population is low but will suffer damage if the soil is heavily infested. The nematode invades corn roots but does not reproduce in them; thus consecutive cropping to corn effectively reduces the population of oat cyst nematodes.

For additional information, see OMAF Factsheet, *Oat-Cyst Nematode*, Agdex 113/632.

INSECTS

Wireworms damage cereal crops in certain areas every year. Injury is usually most severe in the two years following grass sod. As a precautionary measure, use a drill-box formulation containing lindane (see Table 63). Use a wooden paddle to mix the chemical with the seed. Do not breathe the dust stirred up during mixing, wear rubber gloves and a respirator. Follow the precautions in *Precautions with Pesticides* section when using seed treatments.

Armyworms are brown to dark green caterpillars with five longitudinal stripes on their bodies. They are 4 cm long when fully grown. They appear in damaging numbers at intervals of about 10 years except for localized infestations which may appear at any time. The caterpillars appear in grain crops during late June to mid-July depending upon geographical location. They can best be detected by examining crops frequently during early evening just before sunset; at this time the caterpillars are moving up on the plants to feed. They hide under clumps of grass and clods of dirt during the day. **Five to six larvae in an area 30 by 30 cm warrant chemical control.**

If foliage is heavily notched and most of the caterpillars are less than 4 cm long, treat immediately. When plants are completely defoliated and most caterpillars are fully grown, treatment is not practical. Each field must be assessed and dealt with separately. Armyworms often move in large numbers from one field to another. When this happens it is advisable to spray the border of the invaded field. There is no benefit in applying a control measure when the armyworm is nearly full grown, the pupae present, feeding extensive or the crop near "maturity". By this time most of the damage will have been done.

Insecticides are listed in order of preference.

Table 65. Armyworm Control

Insecticide	Product per ha	Days to Harvest
Dylox 420 LC	1.5 L	21
*Lannate 215 L	2.0 L	20

LC (Liquid Concentrate); L (Liquid).

**Minimum period before reentry is 24 hours.*

See Protect Honeybees section and the note below.

Bee Poisoning

During the past several years spraying for armyworms, especially with Sevin, has resulted in heavy bee kills. **This must be avoided.** Treat only when needed. Avoid contamination of areas where weeds are in bloom. Do not spray when the wind is blowing. Treat in the late evening. If spraying by aircraft, avoid spraying close to roadsides and adjacent fields where plants are in bloom. Advise local beekeepers of your spraying activities. Your local Agricultural Representative has a list of beekeepers in your area.

Cereal Leaf Beetle is a metallic blue-green beetle 0.5 cm in length, with reddish-orange head and legs. The larva is slug-like in appearance, 0.6 cm in length when mature and yellowish in color, but its true color is obscured by a black deposit of fecal material. Eggs are pinhead in size, elongate and bright-yellow to dull brown in color and located along the mid-vein on the upper surface of the leaf.

Both the adults and larvae cause damage by chewing long strips of tissue between the leaf veins. However, most of this injury is done by the larvae in June. Heavily damaged fields take on a silvery appearance.

A parasite which generally controls the cereal leaf beetle is now established throughout Ontario, except in parts of Norfolk County. Treatments may be required in some fields when 2 larvae are found per stem.

Quarantine Regulations. A quarantine is in effect to prevent the spread of this insect to western Canada. Growers contemplating selling baled hay or straw to western Canada should contact the local office of the Food Production and Inspection Branch of Agriculture Canada.

Table 66. Cereal Leaf Beetle Control

Insecticide	Product per ha	Days to Harvest
Malathion 500 EC	.55 - 1.1 L	7

EC (Emulsifiable Concentrate).

Grasshoppers. If they become destructive control them as indicated in the Field Bean section.

Aphids. Aphids are often found on cereals but are seldom numerous enough to cause reduced yields. There must be at least 75 aphids per head, the cereal not near maturity and no heavy rains forecast (which wash off some aphids) before spraying would pay. Immigrant aphids carry yellow dwarf virus. Unfortunately it is not possible to kill the aphids efficiently enough to prevent disease transmission to cereals.

INSECTS IN FARM STORED GRAIN

Insects are a major problem in farm stored grain in Ontario. Ontario producers sustain considerable losses annually. In some instances, shipments to elevators are refused because of insects.

The Key to Control of insects in stored grain is prevention through good sanitation and storage. The following are essential:

1. Clean up all spills of grain and feed. Such spilled material usually becomes infested and is a major source of insect problems. All residue grain that is removed should either be burned, deposited in a sanitary fill or ground up for feed.
2. Bins and equipment must be thoroughly cleaned before storing grain. This means cleaning out all caked material. Use a good vacuum cleaner. Such cleaning removes old grain that may be infested with insects that would spread to the new grain. In particular check:

   — corners and cracks
   — behind partitions
   — between double walls
   — outside and under bins
   — grain handling equipment
   — aeration piping
   — perforated floors

There is a major problem with fully perforated floors. They cannot be lifted for cleaning and they get clogged and infested. This is an engineering problem and fumigation is costly and not always effective.

3. New grain must never be stored with old because any insects will spread from the old grain to the new.
4. After clean up, repair storage facilities so that they are pestproof.
5. Any remaining insects that would infest the grain can be killed by spraying the empty bins. Use 250-330 mL of malathion 500 EC in 5 L of water. This will treat 100 m^2 of bin surface. **Treat bins two weeks before grain storage.** Sprays are not a substitute for a thorough and complete clean-up. If bin surfaces are dusty or covered with caked material, the spray will not penetrate or adhere to kill crawling insects.
6. Leave space between feed rooms and storage facilities because feed rooms are difficult to keep free of pests and insects can quickly spread to nearby storage facilities. For the same reason, grain should not be stored in buildings that shelter animals or hay because mangers, feed boxes and troughs are often insect-infested. In addition, such buildings are warmer and thus insects can remain active throughout winter.
7. Molds, as well as insects are much more troublesome in moist grain. If stored grain has more than 15% moisture, check it regularly.
8. Using aeration to cool down grain in the fall will reduce insect infestations. Insects do not develop in grain with temperatures below 18°C. Best grain temperature for long-term storage is 5°C to 10°C.

The above program of sanitation and pest proofing usually prevents pest problems. However, inspect and sample grain regularly. Should an insect problem develop in storage, see OMAF Publication 229, *Insects in Farm Stored Grain*, for recommendations on fumigating. Agriculture Canada Publication 1595, *Insects and Mites in Farm Stored Grain in the Prairie Provinces* is also useful.

Precautions

When handling fumigants follow the safety directions given on the manufactured product. Always work in pairs. Wear the recommended gas mask. Remove livestock or poultry that are in the same building, especially if they are under the grain bin.

Some people experience allergic reactions to grain dust and/or molds. Dust masks or respirators will help prevent this when handling grain.

WEED CONTROL IN CEREAL CROPS

For weed control recommendations, see OMAF Publication 75 *Guide to Weed Control.*

FIELD BEANS AND FIELD PEAS

FIELD BEANS

CROP MANAGEMENT

White beans should be planted between May 20 and June 10 in areas of 2500 to 2900 heat units, and between June 5 and June 20 in areas with greater than 2900 heat units. Planting date of colored beans is dependent upon both variety and heat unit availability. Check with the seed distributor for planting recommendations. The correct date of planting will allow the crop to avoid hot dry weather during flowering and allow harvest during mid-September when favorable harvest conditions are most likely.

Row widths of 70-75 cm are standard for both white beans and colored beans when the bean crop is to be pulled and windrowed. Approximately 250,000 viable seeds per hectare should be planted for a white bean crop, which is a seeding rate of approximately 18 seeds per metre of row or 40 to 55 kg/ha, depending on the seed weight of the variety. Consult the seed distributor for seeding rate recommendations for colored beans.

Row widths of 18-36 cm are standard if the white bean crop is to be direct harvested. Recent testing suggests that 375,000 to 500,000 viable seeds per hectare should be planted to facilitate harvesting. When direct harvest is planned for fields with a history of white mold, a cultivar with a low white mold infection score should be chosen, and the crop should be planted in 36 cm rows.

Table 67. Field Bean Variety Recommendations

					Disease Reaction[2]		
Variety	Heat Unit Rating	Yield[1] (t/ha)	Days to Maturity	100 seed Weight (g)	White Mold Infection[3]	Bean Common Mosaic Virus (%)	Anthracnose Delta race
			White Beans				
OAC Seaforth	2550	2.5	90	21	6	R	R
Mitchell	2550	2.7	93	20	17	R	S
Centralia	2650	2.9	93	22	10	R	R
Midland	2650	2.7	95	18	20	R	S
Suncrest	2700	2.4	96	21	21	R	R
Harokent[4]	2700	2.6	97	24	7	R	R
Rocket	2700	2.6	97	22	15	R	S
Kentwood[4]	2700	2.6	98	24	16	S	S
Wesland	2700	2.7	98	22	12	R	S
Stinger	2750	3.0	99	22	5	R	S
Dresden	2750	2.9	102	20	35	R	R
Fleetside	2800	3.0	101	20	22	R	R
OAC Rico	2800	3.0	102	20	2	R	R

(Continued on Page 64)

Table 67. Field Bean Variety Recommendations

Variety	Heat Unit Rating	Yield[1] (t/ha)	Days to Maturity	100 seed Weight (g)	Disease Reaction[2]		
					White Mold Infection[3]	Bean Common Mosaic Virus (%)	Anthracnose Delta race
Ex Rico 23	2800	3.0	103	21	5	R	S
Crestwood	2800	3.0	105	23	9	R	R
Harofleet	2900	2.8	108	20	37	R	R
				Yellow Eyes			
Aresteuben	2850	1.8	101	43	7	S	R

[1] *Two year average except for Aresteuben (1 year).*

[2] *See also Disease and Insect Recommendations (R-Resistant, S-Susceptible).*

[3] *Average over 2 locations in 1986.*

[4] *May be removed from the recommended list in 1990.*

Table 68. Distributors for Field Bean Varieties

Variety	Distributor
OAC Seaforth	Public variety
Mitchell	Public variety
Centralia	Public variety
Midland	W.G. Thompson and Sons Ltd.
Suncrest	Cooks, W.G. Thompson and Sons Ltd.
Harokent	Public variety
Rocket	W.G. Thompson and Sons Ltd.
Kentwood	Public variety
Wesland	W.G. Thompson and Sons Ltd.
Stinger	W.G. Thompson and Sons Ltd.
Dresden	Public variety
Fleetside	Cooks, W.G. Thompson and Sons Ltd.
OAC Rico	Public variety
Ex Rico 23	Public variety
Crestwood	Cooks, W.G. Thompson and Sons Ltd.
Aresteuben	Public variety

See Distributors Address in General Information Section.

FIELD PEAS

CROP MANAGEMENT

Field peas are best adapted to areas with less than 2900 heat units. They are frost tolerant and should be seeded as early as cereals. For varieties with large and medium sized seed, plant 170-200 kg/ha; for small-seeded varieties plant 130 kg/ha.

If peas have not been previously grown in the field, inoculate the seed with rhizobia.

For additional information see OMAF Factsheet, *Field (Dry) Peas in Ontario*, Agdex 142/13.

Table 69. Recommended Field Pea Varieties and Description

Variety	Seed Size	Seed Colour	Maturity	Yield Index[1] (% of Century)
Century	Large	Yellow	Medium	100
Titan	Large	Yellow	Medium	103
Tipu (semi-leafless)	Medium	Yellow	Medium	93
Trapper	Small	Yellow	Early	94
Triumph	Medium	Green	Medium	90

[1] *Three year average (1986-88) from the New Liskeard College of Agricultural Technology. Because of local adaptation, performance on your farm may differ from that shown.*

Table 70. Distributors for Field Pea Varieties

Variety	Distributor
Century	Public
Titan	SeCan Members
Tipu	SeCan Members
Trapper	Public
Triumph	Public

See Distributor Address in General Information Section.

FERTILIZERS FOR FIELD BEANS AND PEAS

Nitrogen

Nitrogen fertilizers are not usually required for field beans and peas but where phosphate fertilizers are banded a small amount of nitrogen (10 kg N/ha) may improve the availability of the phosphate. Where field bean yields have been low due to bronzing or root rots, apply an additional 100 kg nitrogen per hectare before planting. Under these conditions nitrogen will increase yield but will not cure the bronzing or the root rot.

Phosphate and Potash

Phosphate and potash requirements for field beans and peas are presented in Table 71. For information on use of this table see *Fertilizer Recommendations* in *Soils Section.*

Table 71. Phosphate and Potash Requirements for Field Beans and Peas Based on OMAF Soil Tests

Sodium Bicarbonate Phosphorus Soil Test (ppm)	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Ammonium Acetate Potassium Soil Test (ppm)	Rating	Potash (K_2O_5)[1] Required kg/ha
0- 3		80	0- 15		120
4- 5		60	16- 30		110
6- 7	LOW	50	31- 45	LOW	90
8- 9		40	46- 60		80
10-12		30	61- 80		60
13-15	MEDIUM	20	81-100	MEDIUM	40
16-25	HIGH	0	101-120		30
26-60	VERY HIGH	0	121-150	HIGH	0
61 +	EXCESSIVE[2]	0	151-250	VERY HIGH	0
			251 +	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac.

[1] *Where manure is applied reduce the fertilizer according to the amount and quality of manure (see Manure section in Soils). Example of fertilizer application: If a field bean crop is not manured and the soil tests are 9 for phosphorous and 85 for potassium, the phosphorus requirement is 40 kg/ha and the potash requirement 40 kg/ha (see above table). Ten kilograms of nitrogen are also recommended. These nutrients can be supplied by broadcasting or banding 170 kg/ha 6-24-24 fertilizer.*

[2] *For a nutrient which has an excessive rating by soil analysis, the application of this nutrient in fertilizer or manure may cause problems due to reduced crop yield or quality. Phosphorus additions may also increase the risk of water pollution. Potash additions may induce magnesium deficiency on soils low in magnesium.*

Plant Analysis

For field beans sampling the top fully developed leaf (three leaflets plus stem) at first flowering is recommended. However, plants suspected of nutrient deficiency should be sampled as soon as the problem appears. Expert help will be required to interpret plant analysis results when the samples are not taken at flowering.

A soil sample should be taken from the same area and at the same time as a plant sample.

For more information on plant analysis, see *Plant Analysis* section in *Soils.*

Micronutrients

Manganese deficiency has been diagnosed occasionally in field beans in Ontario, mainly on muck soils or on very sandy soils. Zinc deficiency occurs rarely in field beans; it is most likely to occur in spots where the topsoil has been lost. Field beans are very sensitive to boron and should not be grown the year after rutabagas that received boron.

With manganese deficiency, the upper leaves range from pale green to almost white, with the veins remaining green. Correct the deficiency as soon as it is detected by spraying the foliage with 2 kg of actual manganese/ha from manganese sulphate (8 kg/ha of manganese sulphate) in 200 L of water. Use of a "spreader-sticker" is recommended.

For more information on manganese deficiency and on methods of application, refer to OMAF Factsheet, *Manganese in Soybeans and Small Grain Production,* Agdex 100/531.

Table 72. Interpretation of Plant Analysis for Field Beans[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen (N)	%	4.0	5.5
Phosphorous (P)	%	0.15	0.5
Potassium (K)	%	1.2	2.5
Calcium (Ca)	%	—	5.0
Magnesium (Mg)	%	0.10	1.0
Boron (B)	ppm	10	55
Copper (Cu)	ppm	4	30
Manganese (Mn)	ppm	14	100
Zinc (Zn)	ppm	14	50

[1] *Values apply to the top fully developed leaf (3 leaflets plus stem) at first flowering.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Methods of Application

Fertilizer should not be placed in contact with bean or pea seeds. The fertilizer may be broadcast and plowed down or worked in before planting, or a planter with a separate attachment for fertilizer placement may be used to place the fertilizer 5 cm to the side and 5 cm below the seed. For further information see Table 12, *Maximum Safe Rates of Nutrients* in the *Soils* Section.

DISEASE AND INSECT CONTROL IN FIELD BEANS

(see also Pesticides section)

Seed Treatment

Follow the precautions under *Seed Treatments* in the *General Information on Pesticide Usage* section when applying any chemical seed treatment.

Seed treatments containing diazinon, lindane and a fungicide are required to protect large-seeded crops from seed maggots, wireworms and seed decay organisms. (See Precautions with Pesticides section).

Application of the insecticides alone may result in reduced germination. Diazinon is used to control seed maggots; lindane to control wireworms and the fungicide to control disease organisms. The combination seed treatment should be applied every year.

Combinations of diazinon, lindane and captan are available from seed suppliers in individual containers. Directions stated on the container should be followed with care; the mixing in the planter box must be thorough or germination will be reduced and insect control will be poor. For your protection while mixing the chemicals with the seed, use a wooden paddle and wear rubber gloves and a respirator. Do not breathe the dust stirred up during mixing.

DISEASES

General Preventative Measures

1. All equipment used for cleaning, conveying or planting of seed should be thoroughly washed with detergent to remove all soil. The equipment should then be disinfected with a quaternary ammonium compound (eg. Niagara HY-X) or sodium hypochlorite (eg. 10% Javex). Rinse off the disinfectant with clean water to limit rusting of treated surfaces.
2. Use a two-to-three-year rotation.
3. Do not apply manure containing bean refuse to land intended for beans.
4. Stay out of bean fields when the foliage is wet to avoid spreading diseases.

Bacterial Blight All bean varieties are susceptible to common bacterial blight but most are resistant to Halo Blight. The bacteria usually do not overwinter in the field but, to be safe, allow one year between crops. Almost all infections begin from infected seed. **Do not plant seed which has been harvested from diseased plants.**

Anthracnose The currently recommended varieties of white bean are resistant to alpha, beta and gamma races of anthracnose. Consult Table 67 for varieties resistant to the delta race.

The fungus survives from year to year on seed, on infected plant straw, in the soil and on farm machinery. Rainy weather favors this disease as spores are splashed from diseased areas and carried in wind-borne water droplets throughout the field. For varieties susceptible to the delta race, plant anthracnose-free seed. When the disease condition of the seed is not known, treat with DCT at the recommended rates. This product will not control anthracnose if seed is severely infested. DCT may not contain sufficient diazinon to control seed corn maggot when severe.

Bean Common Mosaic. This virus is seed-borne. Do not use seeds harvested from diseased plants. Disease resistant varieties are available as listed in the table of *Field Bean Variety Recommendations.*

Root Rot and Bronzing (ozone damage) occur in almost every field every year. The amount of damage is related to the general health of the crop as well as to the amount of root-rotting organisms in the soil or ozone in the air. Beans which are not growing well have more injury from root rot and bronzing than vigorous beans.

Eliminating these diseases is impossible. Yield losses caused by them can be reduced by following good soil management practices.

1. Increase nitrogen levels; see *Fertilizers for Field Beans and Peas.*
2. Keep organic matter as high as possible.
3. Maintain or build up good soil tilth by not overworking the soil or working it when it is too wet.

White Mold (Sclerotinia) usually begins to appear by mid-August. The fungus disease develops from windblown spores produced from small black bodies (sclerotia) that survive in the soil over winter. The sclerotia are found on and in stems and pods of infected plants and at harvest are scattered over the soil. These sclerotia are not toxic to livestock. Initial infection occurs on plant tissues such as older flowers or possibly lower leaves that have died from other causes. Infection of healthy pods, stems and leaves results from infected plant parts coming in contact with healthy plant tissues. Weather conditions, especially rainfall, play a critical role in disease development. In areas where disease is widespread, crop rotation especially after soybeans, canola or sunflowers, has not given control. Spraying with fungicides is considered essential in fields with the following conditions.

— a past history of white mold;
— above average foliage growth;
— exposure to continuous wetness and air temperatures between 15 and 20°C (day and night temperatures) for more than 48 hours (fewer hours if temperatures are higher).

For most effective control, foliar sprays must be applied at first bloom prior to appearance of disease. Sprays applied after disease first appears do not control white mold effectively.

Table 73. White Mold Control

Fungicide	Product per ha
Benlate 50 W	1.7-2.25 kg
Rovral 50 W	1.0-1.5 kg
Easout 70 W	1.75-2.25 kg
Botran 75 W	3.25 kg

W (Wettable Powder).

Do NOT feed treated bean refuse to livestock.

INSECTS

Green Cloverworm is a greenish caterpillar that feeds on bean foliage, causing holes in leaves and reducing yield. Shake worms from plants onto paper to count them. If more than five caterpillars are found per 30 cm of row, apply an insecticide as listed in Table 74.

Table 74. Cloverworm Control

Insecticide[1]	Product per ha	Days to Harvest
Thiodan 4 EC	1.4 L	2
*Guthion 240 SC	1.75-2.25 L	3

EC (Emulsifiable Concentrate); SC (Sprayable Concentrate).

**Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*

[1] *These insecticides are toxic to honeybees and growers must use appropriate caution. See Protect Honeybees section.*

Mexican Bean Beetle

Mexican bean beetles are oval in shape with 16 small black spots on their otherwise yellowish back. The larvae are easily identified by their yellow color and the presence of six rows of long branching, black-tipped spines. Growers should treat their plants when this insect is causing damage.

Potato Leafhoppers

Potato leafhoppers are pale green, wedged-shaped insects about 0.3 cm long. They are best identified by observing how they walk. They can walk equally well forwards, backwards and sideways when disturbed.

Leafhoppers may cause reductions in yield when they are numerous early in the season and the crop is under stress. The flowering and early pod-fill stages are also important. If leafhoppers are numerous at first cultivation, control measures should be taken. Recheck fields at last cultivation (just before the crop fills the rows) to see whether another application is necessary. Normally, applications at last cultivation will control leafhoppers well into pod-fill. When control is necessary apply one of the insecticides in Table 75.

Table 75. Mexican Bean Beetle and Leafhopper Controls

Insecticide	Product per ha	Days to Harvest	Comments
Cygon 480 E	0.7-1.0 L	7	Do not use straw for feed or bedding.
Thiodan 4 EC	1.4 L	2	
*Guthion 240 SC	2.25 L	3	
Malathion 500 EC	1.3-2.5 L		

E or EC (Emulsifiable Concentrate); SC (Sprayable Concentrate).

**Minimum period before reentry into treated area is 48 hours. See Reentry into Treated Areas section.*

Follow precautions applying to honeybees. See Protect Honeybees section.

Grasshoppers Maintain weed-free headlands and fencerows. If grasshoppers become a problem, spray outer rows of the field.

Table 76. Grasshopper Control

Insecticide[1]	Product per ha	Days to Harvest
Basudin 50 W	1.1 kg	14
Diazinon 50 WP	1.1 kg	14
Malathion 25 WP	3.4 kg	7
500 EC	1.7 L	

E or EC (Emulsifiable Concentrate); W (Wettable Powder); WP (Wettable Powder).

Follow precautions applying to honeybees. See Protect Honeybees section.

WEED CONTROL IN FIELD BEANS AND PEAS

For weed control recommendations see OMAF Publication 75, *Guide to Weed Control.*

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre.

SPRING CANOLA AND WINTER RAPESEED

SPRING CANOLA

CROP MANAGEMENT

Spring canola is a cool season crop suited to areas with less than 2700 heat units.

Seeding should be done as early as soil conditions permit. Planting time should be late April to early May. Yield reductions will occur if seeding is delayed. Plant 4 to 5 kg/ha of seed in 18 cm rows (15 to 20 seeds per metre) with a grain drill or Brillion-type seeder into a fine, firm seedbed. Planting depth should be 2 to 3 cm if there is adequate moisture, and deeper if necessary to plant in moisture, but not deeper than 4 cm. If a granular insecticide is to be used for flea beetle control, it should be thoroughly mixed with the seed before calibrating the drill.

Canola is highly susceptible to phenoxy herbicides such as 2,4-D and MCPA. Be sure spraying equipment is cleaned out thoroughly before using on canola.

Spring canola should be swathed when 25% of the seeds in pods from the middle portion of the plants have changed colour from green to red or brown. Leave as long a stubble as possible. Swathing when the crop is moist aids flow through the swather. Canola in the swath matures in 5 to 10 days under ideal weather. Seed can be marketed at 10% moisture but for long-term storage 8% moisture is recommended. Under good drying conditions, moisture content drops rapidly and combining can begin at about 12% moisture.

For additional information see OMAF Factsheet, *Spring Canola in Ontario,* Agdex 149/10.

VARIETY SELECTION

All varieties shown in Table 77 are Argentine-type varieties recommended for most areas with less than 2700 heat units.

OAC Triumph and **OAC Triton** are Argentine-type, triazine-resistant varieties recommended in Ontario. Triazine herbicides (see *Weed Control in Canola*) can be used to control wild mustard and other weeds without damaging the crop. Consider growing triazine-resistant varieties in fields that have mustard problems because mustard seed cannot be cleaned out of canola. More that 5% mustard contamination can mean rejection of the canola by elevators or crushers.

BEFORE
USING
ANY PESTICIDE
STOP
READ THE LABEL
CAREFULLY

Table 77. Recommended Spring Canola Varieties

Variety	Days from planting to maturity	Yield[1,2] (t/ha)	Lodging 1=standing 5=flat	Distributor[3]
Westar	94	2.00	2.3	SeCan Members
Legend	95	2.12	2.2	Bonis & Co. Ltd.
Vanguard	97	2.12	2.1	Bonis & Co. Ltd.
Celebra	98	2.18	1.5	Bonis & Co. Ltd.
Delta	99	2.33	1.8	W.G. Thompson & Sons Ltd.
Topas	100	2.01	1.3	Bonis & Co. Ltd.
Comet	101	2.20	1.4	W.G. Thompson & Sons Ltd.
Global	102	2.33	1.5	Bonis & Co. Ltd.
Triazine-Resistant				
OAC Triton	99	1.55	2.8	SeCan Members
OAC Triumph	101	1.49	1.6	SeCan Members

[1] *1 t/ha = 893 lb/ac = 17.86 bu/ac.*

[2] *Values shown are averages of 18 trials over 3 years.*

[3] *See Distributor Addresses in General Information section.*

FERTILIZERS FOR SPRING CANOLA

Nitrogen

Nitrogen fertilizer recommendations for canola are based on expected yield and adjusted downward if manure was applied, or if the previous crop contained legumes such as alfalfa (see Tables 4 and 5).

Table 78. Nitrogen Requirements for Spring Canola

Price Ratio[2]	Expected Yield[1]--t/ha			
	1.5	2	2.5	3
	Most profitable nitrogen application[3] (kg N/ha)			
500	125	150	165	175
400[4]	100	130	150	160
300	60	100	125	140

[1] *t/ha = 893 lb/acre.*

[2] *To use the table, the price of canola must be known or estimated. Canola at $320/t and nitrogen at $.65/kg results in a price ratio of 500 (320 ÷ 0.65). At these prices and an expected yield of 2.0t/ha you should use 150 kg/ha of nitrogen.*

[3] *Nitrogen rates should be adjusted downward if the preceding crop was a legume sod (see Nitrogen Adjustment for Legumes Plowed Down section) or if manure is applied (see Manure section in Soils).*

[4] *The highlighted area represents the most appropriate ratio at time of printing.*

Phosphate and Potash

Phosphate and potash requirements for canola are given in Table 79. For information on use of this table see *Fertilizer Recommendations* in *Soils* section.

DISEASE AND INSECT CONTROL IN SPRING CANOLA

(see also Pesticides section)

Seed Treatment

Canola seed should be treated with a combination of fungicide and insecticide. The fungicide is required to control seed-borne and early soil-borne diseases, especially blackleg, seed decay, damping-off and seedling blight. Insecticides are to control flea beetles on emerging canola. Seed may have been commercially treated. Untreated seed should be treated by the grower. Use the following at rates recommended on the label.

Table 80. Canola Seed Treatments

Seed Treatment	Formulation[1]	Fungicide	Insecticide
Vitavax RS	F	3.3% carbathiin 6.6% thiram	50% lindane
Rovral ST	F	16.7% iprodione	50% lindane

[1] *F (Flowable).*

DISEASES

White mold (Sclerotinia) is characterized by bleached stem lesions, hard black bodies (sclerotia) of white mold fungus inside the stems, and premature ripening of the plants. The disease is often a problem when canola follows canola, white beans, soybeans or sunflowers. Use clean seed and rotations of at least four years including unaffected crops such as corn, wheat, barley or oats. Treatment with a fungicide may be advisable when

Table 79. Phosphate and Potash Requirements for Spring Canola Based on OMAF Soil Tests

Sodium Bicarbonate Phosphorus Soil Test (ppm)	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Ammonium Acetate Potassium Soil Test (ppm)	Rating	Potash (K_2O)[1] Required kg/ha
0 - 3		70	0 - 15		70
4 - 5	Low	60	16 - 30	Low	50
6 - 7		50	31 - 45		40
8 - 9		30	46 - 60		30
10 - 12		20	61 - 80		20
13 - 15	Medium	20	81 - 100	Medium	20
16 - 20		0	101 - 120	High	0
21 - 25		0	121 - 150		0
26 - 30	High	0	151 - 180	Very High	0
31 - 40		0	181 - 210		0
41 - 50	Very High	0	211 - 250		0
51 - 60		0	251+	Excessive[2]	0
61+	Excessive[2]	0			

100 kg/ha = 90 lb/ac.

[1] *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure section in Soils).*

[2] *Excessive ratings may cause reduced yield or quality of the crop.*

conditions favor white mold but the fungicide must be applied **before** symptoms appear. The risk of white mold is high when the disease developed in previous crops, when the canola stand is dense and vigorous, and when several days of wet weather precedes the early flowering stage. Fungicides should be applied at the 20 to 30% bloom stage of canola, in a minimum of 80 L/ha of water with ground equipment, or 45 L/ha of water with aerial application.

Blackleg (Phoma) Blackleg was noticed in several Ontario spring canola fields in the summer of 1986. Refer to Disease section, Winter Rapeseed.

INSECTS

Flea beetles Two species of flea beetle attack canola. The striped flea beetle is about 1.5 mm long and has two cream-colored stripes along its back. The crucifier flea beetle is entirely bluish-black and about the same size. Flea beetles jump when disturbed, thus their common name. The adults eat holes through leaves. Larvae feed on the roots of canola and other cruciferous plants but are not considered damaging.

Both kinds of flea beetle overwinter as adults and can attack canola in the spring after germination. Damage is most severe during the initial three weeks following germination, when young seedlings are killed or seriously damaged. Feeding on the foliage continues during the season but more mature plants are less severely affected. Severe infestations have caused 50% reductions in yield.

Control measures should be directed against the beetles during the early stages of seedling growth. Seed treatments (Table 80) should always be used because they provide protection from seed- and soil-borne diseases and protect the young seedlings from flea beetles. (See the preceding section for information on seed treatments.) However, flea beetles can attack suddenly after the effect of the seed treatment is gone so a granular applied with the seed (Table 81) is also recommended. This combination of seed treatment and granular at planting provides the best protection. Heavily infested areas also may require a foliar spray to control flea beetles. Check the seedling fields regularly, especially along weedy borders. More severe damage is expected in such areas because of the proximity of the overwintering sites of the beetles.

Diamondback Moth The adult is a small light brown moth about 1 cm long. It is best identified by the white diamond-shaped markings along the back when the wings are at rest. Apparently this pest does not overwinter in Ontario. The severity of attack is dependant on the number of moths carried into Ontario each spring on weather systems.

Damage is caused by the larvae which are light green with brown heads and are about 1 cm long when mature. There are three or four generations in Ontario. They feed on the foliage and when numerous they will feed on the pods. This damage results in premature senescence and shattering of pods at harvest.

CERTIFIED
SEED
USE IT FOR ALL IT'S WORTH!

Table 81. Flea Beetle Control

	Product per ha	Days to harvest
Seed-furrow application:		
Counter 5G	5.5-11 kg	Planting time only
Furadan CR-10G	2.8 kg	
Postemergent spray:		
Cymbush 250 EC	140 mL	30
Ripcord 400 EC	50 mL	30
Decis 2.5 EC	200-300 mL	14
*Furadan 480 F	150-275 mL	60
*Guthion 50 WP	150-275 g	30
240 SC	275-550 mL	30

G (Granular); F (Flowable); WP (Wettable Powder); SC (Sprayable Concentrate); EC (Emulsifiable Concentrate); CR (Special formation for Canola Rape).

**Minimum period before reentry into treated areas is 48 hours. See reentry into Treated Areas.*

Table 82. Diamondback Moth Control

Product	Product per ha	Days to Harvest
Dylox[1] 80% SP	1.5 kg	21
420 L	2.75 L	21
*Guthion 50 WP	275-550 g	30
240 SC	.55-1.25 L	30

SP (Soluble Powder); L (Liquid); WP (Wettable Powder); SC (Sprayable Concentrate).

[1] Use Dylox if canola is in bloom because it is less hazardous to bees.

**Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*

Caution: Canola is a valuable honey source and is well used by honeybees. Bees aid in pollinating the crop. Applications of insecticide should be kept minimal while the crop is in bloom. See Protect Honeybees Section and take appropriate caution.

WEED CONTROL IN CANOLA

For weed control recommendations, see OMAF Publication 75, *Guide to Weed Control.*

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre.

WINTER RAPESEED

CROP MANAGEMENT

Under good management, winter rapeseed has greater yield potential than spring canola. Winter rapeseed is best suited to areas with good winter snow cover, low risk of ice accumulation and moderate climate.

Winter rapeseed grows best on loam or sandy-loam soils. Poorly drained soils and heavy clay soils should be avoided since root heaving may occur.

Seeding should be done August 15-30 (Aug. 20-Sept. 10 in Kent and Essex Counties) into a level, firm, moist seedbed. Plant 4 to 5 kg/ha of seed in 18 cm rows (15 to 20 seeds per metre) with a grain drill. Broadcast seeding is recommended only if soil fertility and tilth are optimal. Plant to a depth of 2 to 3 cm or to moisture, but do not exceed 4 cm. If a granular insecticide is to be used for flea beetle control, it should be thoroughly mixed with the seed before calibrating the drill.

Winter rapeseed is highly susceptible to phenoxy herbicides such as 2,4-D and MCPA and is also susceptible to triazine herbicides. Swath when 50-60% of the seeds in pods from the middle portion of the plants have changed from green to black or direct-combine when seed moisture is 10% or lower, unless drying facilities are available. Winter rapeseed in the swath will be ready to combine in 5 to 10 days under good weather conditions. Seed can be marketed at 10% moisture but for long-term storage 8% moisture is recommended.

VARIETY SELECTION

Growers may choose among several varieties of winter rapeseed (see Table 83). All are Argentine-type.

FERTILIZERS FOR WINTER RAPESEED

Nitrogen

Fall Application

Apply up to 40 kg/ha of nitrogen in the fall. If the land was fallowed for one or more months before planting, or if forage legumes were plowed down, or manure applied before planting, no fertilizer nitrogen should be applied.

Spring Application

The rate for spring application of nitrogen is given in Table 84.

Table 84. Spring Nitrogen Requirements for Winter Rapeseed

	Expected Yield[1]-t/ha		
Price Ratio[2]	2	3	4
	Most profitable nitrogen application (kg N/ha)		
500[3]	180	210	220
400	160	195	210
300	125	170	195

[1] t/ha = 893 lb/acre.

[2] To use this table, the price of canola must be known or estimated. Canola at $320/t and nitrogen at $.65/kg results in a price ratio of 500 (320 ÷ 0.65). At these prices and an expected yield of 3.0 t/ha you should use 210 kg/ha of nitrogen.

[3] The highlighted area represents the most appropriate ratio at time of printing.

Phosphate and Potash

For phosphate and potash recommendations see section on *Fertilizers For Spring Canola.*

Table 83. Recommended Winter Rapeseed Varieties

Variety	Yield[1,3] (t/ha)	Winter[2] Survival (%)	Lodging 1=standing 5=flat	Distributor[4]
Arabella	2.86	81.5	1.3	Agri Seed Ltd.
Tandem	2.85	86.6	1.4	King Agro
Ceres	2.76	81.3	1.3	King Agro
Crystal	2.68	79.9	1.4	Bonis & Co. Ltd.
OAC Winfield	2.64	77.4	1.3	Allelix Inc.

[1] 1 t/ha = 893 lb/ac = 17.86 bu/ac.

[2] Values shown for winter survival are averages of 9 trials over 3 years.

[3] Values shown for yield and lodging are averages of 12 trials over 3 years.

[4] See Distributor Addresses in General Section.

DISEASE AND INSECT CONTROL IN WINTER RAPESEED

Seed Treatment

Refer to *Seed Treatment section, Spring Canola.*

DISEASES

Blackleg (phoma) Blackleg was found in 92% of winter rapeseed fields surveyed in the summer of 1986. A few fields had severe disease symptoms that contributed to a yield loss of up to 35%. The first symptoms appear on cotyledons or leaves as round to irregular (1-2 cm), white to buff-coloured lesions dotted with numerous small, black fruiting bodies (pycnidia). As the season progresses, the fungus may spread to the stem and crown of the plant producing a canker (often containing pycnidia) that can girdle the stem. Severely infected plants ripen prematurely and have a black to grey discolouration at the base of the stem or crown. Seeds of severely infected plants are small, shrivelled and may be infected with the fungus. To control the disease, obtain seed from a reliable seed source and treat seed with a fungicide (Table 80). Use a 4 year rotation with crops other than crucifers. Beware of planting rapeseed adjacent to fields of previous rape since airborne spores may be released from old crop stubble for up to 3-4 years. Efficient plough-down of stubble and control of volunteer rape and cruciferous weeds will help to reduce disease levels.

White mold (Sclerotinia) Refer to *Disease section, Spring Canola.*

BEFORE
USING
ANY PESTICIDE
STOP
READ THE LABEL
CAREFULLY

Turnip Mosaic Virus (TuMV) has become a significant problem in some areas where winter rapeseed is grown. Infestation takes place in the fall, and causes leaf mottling (yellow or light green areas surrounded by normal green colour), and wrinkling or puckering of the leaf tissue between the veins. Spring growth is slow. Severely infected plants are stunted, twisted, and generally light green to yellow in color. Pods are distorted and a significant proportion of the seed are poorly filled. The disease appears to be more severe in areas where other cruciferous crops are grown, and in fields where pressure from weeds and volunteer cereals is high. Volunteer crops of winter rapeseed often have high levels of TuMV infections. Early planting may be helpful in increasing winter survival of the crop in some areas, but appears to also increase the severity of TuMV where the disease is present. Only minor levels of TuMV infection have been observed in spring canola.

INSECTS

Flea beetles Refer to Table 81. *Flea Beetle Control in the Insect* Section, *Spring Canola.* Flea beetle damage is generally limited to the fall period in winter rapeseed.

WEED CONTROL IN WINTER RAPESEED

For weed control recommendations, see OMAF Publication 75, *Guide to Weed Control.*

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre.

MINOR CROPS

FERTILIZERS FOR MINOR CROPS

Table 85. Nitrogen Requirements — Minor Crops

Crops	N Required[1] kg/ha
Buckwheat, Millet (S. Ontario)	35
Buckwheat, Millet (N. Ontario)	55
Flax, Fodder Rape, Kale (S. Ontario)	45
Flax, Fodder Rape, Kale (N. Ontario)	70
Mustard	50
Sorghum	100
Sunflower	90

100 kg/ha = 90 lb/ac.

[1] Where manure is applied or the preceding crop is a legume sod, reduce the nitrogen rates as shown in Tables 4 and 5.

Table 86. Phosphate Requirements for Minor Crops Based on OMAF Soil Tests

	Sorghum, Sunflower		Buckwheat, Flax, Fodder Rape, Kale, Millet, and Mustard	
Sodium Bicarbonate Phosphorus Soil Test (ppm)	**Rating**	**Phosphate (P_2O_5)[1] Required kg/ha**	**Rating**	**Phosphate (P_2O_5)[1] Required kg/ha**
0- 3		110		70
4- 5	Low	100	Low	60
6- 7		90		50
8- 9		70		30
10-12		50	Medium	20
13-15	Medium	20		20
16-20		20		0
21-25	High	20	High	0
26-30		20		0
31-60	Very high	0	Very high	0
61+	Excessive[2]	0	Excessive[2]	0

100 kg/ha = 90 lb/ac.

[1] Where manure is applied reduce the fertilizer application according to the amount and quantity of manure (see Manure Section in Soils). For sunflowers, not manured and not following a legume sod the nitrogen requirement is 90 kg/ha (see Table 85). If the soil tests are 11 for phosphate and 90 for potash, then 50 kg/ha of each would be required. An application of 200 kg/ha of 6-24-24 would supply 12 kg of nitrogen and 48 kg/ha of phosphate and 48 kg/ha of potash. The additional 78 kg/ha of nitrogen could be supplied by 175 kg/ha of 45-0-0.

[2] Excessive ratings may cause reduced yield or affect nutrient balance in crops and increase the risk of water pollution.

Table 87. Potash Requirements for Minor Crops Based on OMAF Soil Tests

	Sorghum, Sunflower		Buckwheat, Flax, Fodder Rape, Kale, Millet, and Mustard	
Ammonium Acetate Potassium Soil Test (ppm)	**Rating**	**Potash (K_2O)[1] Required kg/ha**	**Rating**	**Potash (K_2O)[1] Required kg/ha**
0- 15		170		70
16- 30		160	Low	50
31- 45	Low	140		40
46- 60		110		30
61- 80		80	Medium	20
81-100	Medium	50		20
101-120		30	High	0
121-150	High	0		0
151-180		0	Very high	0
181-210	Very high	0		0
211-250		0		0
250+	Excessive[2]	0	Excessive[2]	0

100 kg/ha = 90 lb/ac.

[1] Where manure is applied reduce the fertilizer application according to the amount and quantity of manure (see Manure Section in Soils).

[2] Excessive ratings may cause reduced yield or quality of crops primarily due to magnesium deficiency. Natural levels above 250 occur occasionally on clay and clay loam soils but are not expected to cause problems because soils naturally high in potassium are usually high in magnesium.

CERTIFIED
SEED
USE IT FOR ALL IT'S WORTH!

GENERAL INFORMATION ON PESTICIDE USAGE

Brands of a pesticide from different companies often have different concentrations of the same chemical in them. Consequently, if you use one with a concentration different from that listed in the recommendations in this publication, you will need to adjust the rate of application so that you will be applying the same amount of actual chemical (active ingredient).

PRECAUTIONS WITH ALL PESTICIDES

Read this entire section before using any pesticides:

GENERAL PRECAUTIONS

1. Always read the label before opening pesticide containers, and follow all precautions and directions. Before starting, keep a record of the common names of all pesticides handled, especially those listed as hazardous in this publication. This list should be known by members of your family for use in the event of an accident.
2. Use an anti-backflow device, to prevent back siphoning, when drawing water from wells, ponds, streams and other sources of water. Mix pesticide into the tank with sprayer at least 50 m from the water source. Triple or pressure rinse the empty container and add rinse water to tank. Only mix enough solution to do the spray job. After loading and mixing, wash down gloves and boots with clean water before removing.
3. Never smoke, chew tobacco or eat while handling or applying pesticides. Do not carry tobacco or food items in clothes worn while spraying. Change clothing and wash before eating.
4. When handling and mixing pesticide concentrates, rinsing empty containers or repairing leaks, a full set of protective clothing should be worn including waterproof cap, coveralls, impervious gloves and boots, and eye protectors. If highly or extremely toxic pesticides are being used, a respirator should be worn. If very dusty formulations are being handled, a dust mask should be used. If volatiles or gases are being handled, a respirator must be worn. If these gases are highly dangerous or in an enclosed space, a self-contained breathing apparatus may be needed.
5. During application, a tractor cab with charcoal filter gives adequate protection against exposure. Impervious gloves, boots, coveralls and cap should be worn when tending to stoppages. When using airblast and mist blowers and tractors without cabs, waterproof suits including caps and impervious gloves and boots should be worn. When applying fumigants in the field, a respirator should be available for use in the event of problems with equipment, or escape of fumigant due to inadequate sealing in the soil.
6. When the spray operation is complete, rinse gloves and boots before removal. All protective clothes should be double laundered, separately from normal laundry. Underwear should be changed daily. It is wise to change to clean clothes twice a day, at lunch and at the end of the day. Take a bath or shower after spraying to remove pesticide deposits on the skin. Avoid handling anything in the home before bathing.
7. Use OSCEPAP II grants to provide facilities to protect your water supply and assist in building a place for storing your pesticides.

IF ACCIDENTS OCCUR

1. If an accident occurs, remove contaminated clothing including underclothes immediately, and wash contaminated skin thoroughly with soap and water. Wash gloves, boots, respirator before and after removal. Presoak clothes and double launder immediately. If the spill was serious, place the clothes in a plastic bag and dispose of in a safe manner.
2. If clothing becomes wet with a pesticide during spraying, remove it immediately, wash and put on freshly laundered clothes.
3. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to a hospital immediately. Take the list of common-name chemicals with you to the hospital (see Emergency Procedures for Pesticide Poisoning on the back cover).
4. Clean up any pesticide spills immediately. In the case of minor spills, use dry soil or other absorbent material to remove excess liquid and sweep up powders and granulars. Contaminated soil and sweepings should be spread over a larger area of bare soil to facilitate rapid degradation. Make sure you are adequately protected when cleaning up the spill.

   In the case of a major pesticide "spill', the Ministry of the Environment, Spills Action Centre, 5th Floor, 7 Overlea Blvd., Toronto, Ontario, M4H 1A8, Telephone (416) 965-9619 or 1-800-268-6060 must be notified.
5. If a well becomes contaminated, follow clean-up instructions in OMAF Factsheet, *Pesticide Contamination of Farm Water Supplies*, Agdex 607.

EMERGENCY PROCEDURES FOR PESTICIDE POISONING AND FIRST-AID INFORMATION

(See Back Cover)

RELATIVE TOXICITY TO APPLICATOR

DEFINITIONS

Lethal Dose 50% (LD_{50}) The dose which when administered will kill 50% of the test animals within a stated period of time (i.e. 1 to 6 days).

Acute Toxicity Immediate adverse effects from a single or short period exposure to a substance, either by the oral, dermal or inhalation route.

Chronic Toxicity Adverse effects resulting from repeated exposure to a substance over an extended period.

High Acute Toxicity

These pesticides are extremely dangerous if handled carelessly. The acute oral LD$_{50}$ are less than 50 mg/kg of body weight and the acute dermal LD$_{50}$ less than 200 mg/kg body weight. These pesticides can be fatal on taking less than 0.1 to 3 ml (one drop to half a teaspoonful). These pesticides carry the skull and crossbones in a stop sign. In using these products a respirator and eye protection is required along with all other protective clothing.

azinphos methyl (Guthion)
carbofuran (Furadan)
disulfoton (Disyston)
endosulfan (Thiodan)
fensulfothion (Dasanit)
fonofos (Dyfonate)
methomyl (Lannate)
phorate (Thimet)
terbufos (Counter)
terbufos + phorate (Cygard 15-6)

Moderate Acute Toxicity

These pesticides are dangerous if handled carelessly. The acute oral LD$_{50}$ is 50 to 500 mg/kg of body weight and the acute dermal LD$_{50}$ is 200 to 2000 mg/kg body weight. These pesticides can be fatal on taking 3 to 30 ml (half a teaspoonful to 2 tablespoonfuls). These pesticides carry the skull and crossbones on a stop sign. In using these products a respirator is recommended when handling the concentrate.

chlorpyrifos (Lorsban)
diazinon (Basudin)
dimethoate (Cygon)
phosmet (Imidan)

Low Acute Toxicity

These pesticides are not fatal unless deliberately ingested in amounts of over 30 ml (1 oz.). The acute oral LD$_{50}$ is greater than 500 mg/kg body weight and the acute dermal LD$_{50}$ greater than 2000 mg/kg body weight. Pesticides listed in this publication and not appearing in the lists in this section have low acute toxicities and should be handled with caution. Protective clothing is required. Respirators are advised when used in confined spaces. Eye protection is advisable.

Chronic Toxicity

It is not possible to assess chronic toxicity of a pesticide in the same way as an LD$_{50}$ is used to determine acute toxicity. Instead, a number of tests are performed on animals which help predict whether a pesticide will cause a number of possible long-term effects. Animals are examined for a wide variety of toxic effects such as the production of tumours or abnormalities. Protective clothing and equipment is advisable to reduce exposure and the risk of chronic effects.

BLOOD TESTS FOR THOSE APPLYING PESTICIDES

Organophosphorus and carbamate pesticides are capable of inactivating and depressing the serum and red blood cholinesterase levels. If the activity of cholinesterase falls below a critical level, human poisoning can result as exhibited by fatigue, dizziness, nausea, trembling, blurred vision, difficulty in breathing and other symptoms. For those working outdoors and applying these groups of pesticides, it is strongly recommended that cholinesterase levels be checked by your family doctor. To be of value the tests should begin prior to using these pesticides and not after applications have commenced because the normal level per individual can vary considerably making it difficult to assess the degree of suppression. In this publication the primary insecticides of concern are those listed as high and moderate acute toxicity.

PROTECTIVE CLOTHING WHEN USING PESTICIDES OUTDOORS

1. **Why Use Personal Protection?** Pesticide formulations vary in their toxicity from slightly to extremely poisonous. Once the pesticide is removed from the container, exposure occurs. The toxicity of the pesticide and the exposure to the user creates a hazard which varies from spray operation to spray operation. Both can be reduced, toxicity by dilution and exposure by protective clothing. The action taken by the applicator to reduce the hazard of a spray operation reduces the risk of poisoning. While the hazard of a situation remains, the risk can be changed by the care and protection followed by the applicator. Wearing the required protective clothing reduces the risk to a minimum.
2. **Risk of each stage in pesticide operation.**
   1) Handling and mixing concentrate — very high risk
   2) Rinsing empty containers — high risk
   3) Application outdoors — low to high risk
   4) Application indoors — medium to very high risk
   5) Cleanup, equipment rinsing — medium to high risk
   6) Reentry into treated area within 48 hours — low to medium risk.
3. **Exposure can be by way of skin, eyes, mouth or nose.** Approximately 80-85% of the exposure in most spray opertions is during mixing and loading of the concentrate. Field application usually accounts for 15-20% of the exposure. Skin exposure is usually 90 to 100% of the total exposure and around 70% of this is by way of the hands and forearms and 30% involves the rest of the body. Inhalation (nose and mouth) exposure is normally 0.1% but rises to 5-10% with mist blowers and air blast sprayers.
4. **To reduce skin (dermal) exposure,** wear impervious gloves (neoprene, rubber, etc.) and waterproof boots, along with coveralls, apron or spray suits and waterproof cap. Coveralls can be reusable or disposable. Reusable coveralls are normally cotton or polyester and should be tightly woven. Polyester is more easily penetrated than cotton. Disposable coveralls are polyethylene and can be laundered several times. Spray suits should be used in highly hazardous conditions as with mist blowers and air blast machines. Eye protection should be practised with all pesticide concentrates.
5. **Respirators are recommended** when handling pesticides with labels that call for respiratory protection and carry the warning stop sign with skull and crossbones. Respirators should be used when spraying all pesticides rated as high toxicity or when applying any liquified gas. Respirators are available as air purifiers or self-contained units. Respirators come in a wide range of shapes and sizes; consult the label and your nearest safety supply company for advice.

6. **Protective clothing deteriorates and pesticides eventually break through** to the skin. It is wise to check and replace where clothing is worn out, cracked, torn or severely abraised. All protective clothing should be washed after each use including respirator, boots, gloves and spray suits. After use decontaminate and dry before storing in a clean and dry place.
7. **Consult the safety supply house** of your choice for appropriate guidance and selection of your protective clothing.

Table 88. Safety Supply Companies in Ontario Providing Protective Clothing and/or Respiratory Devices for Outdoor Protection Against Certain Pesticides.

Respiratory Devices Manufactured By	Available From
American Optical	AOCO Limited, Subsidiary of American Optical Corporation, 80 Centurion Drive, Markham L3Y 5Y5 Tel (416) 479-4545 Branches: Hamilton & Belleville
H.S. Cover (York)	Levitt-Safety Ltd., 33 Laird Drive, Toronto, M4G 3S9 Tel. (416) 425-8700 Branches: Kitchener, London, Ottawa, Sarnia, Stoney Creek, Sudbury and Thunder Bay.
Kasco Helmets	The St. George Co., St. George, RR1, N0E 1N0 Tel. (416) 442-2046
Mine Safety Appliances	MSA Canada Inc., 148 Norfinch Drive, North York, M3N 1X8 Tel. (416) 667-9400
3M Occupational Health & Safety Products Div.	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill, (Toronto) L4B 1E7 Tel. (416) 222-4111 (416) 222-2111 Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay and Windsor.
North	Siebe-North Inc., 26 Dansk Court, Rexdale, M9W 5V8 Tel. (416) 675-2810
Racal Airstream	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill, (Toronto) L4B 1E7 Tel. (416) 222-4111 (416) 222-2111 Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay and Windsor.
Safety House	Safety House of Canada Ltd., 127 Castlefield Ave., Toronto, M6B 1G4 Tel. (416) 789-0631 Branches: Kitchener, London, Orillia, Ottawa, St. Catharines & Stoney Creek.
Scott	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill, (Toronto) L4B 1E7 Tel. (416) 222-4111 (416) 222-2111 Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay and Windsor.
Survivair	Levitt-Safety Ltd., 33 Laird Drive, Toronto, M4G 3S9 Tel. (416) 425-8700 Branches: Kitchener, London, Ottawa, St. Catharines, Sarnia, Stoney Creek, Sudbury and Thunder Bay.
Willson	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill, (Toronto) L4B 1E7 Tel. (416) 222-4111 (416) 222-2111 Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay and Windsor.

Many of the companies listed above have dealer outlets in addition to branch outlets. For details of dealer outlets contact the supply company of your choice.

REENTRY INTO TREATED AREAS

Pesticide poisoning may occur where workers enter fields too soon after pesticides have been applied. Such poisoning can result from handling treated plants or from inhalation of pesticide vapors.

The pesticides listed below are those for which a specific minimum interval must be observed from the time of application to the time of working in the crop. For some pesticides, e.g. parathion, the label carries a warning regarding working in treated crops. **Follow these recommendations.** Where no label warnings are provided, the following minimum intervals are recommended.

24 Hours	48 Hours
methomyl (Lannate)	azinphos-methyl (Guthion)
	carbofuran (Furadan)

PROTECTIVE CLOTHING WHEN USING PESTICIDES IN GRAIN STORAGES AND OTHER ENCLOSED AREAS

Respiratory Protection — Available Devices

Air-Purifying Devices — Canister Gas Masks

Canister gas masks have been used effectively for many years by greenhouse applicators for respiratory protection against certain gases, vapors and particulate matter which otherwise might be harmful to life or health.

From a practical standpoint, canister gas masks are generally suitable for ventilated areas not subject to rapid change, but should never be used in confined spaces where oxygen deficiency and high gas concentrations may occur.

Self-contained Breathing Apparatus

In confined spaces where gas concentrations are unusually high oxygen can be deficient and conditions can be fatal. Under these conditions, air purifying apparatus do not work. The applicator needs an air supply and this is provided by a self-contained breathing apparatus (e.g. Scott Air Pack). The use of substances that produce hydrogen cyanide, methyl bromide, chloropicrin, or phosphine can all produce high gas concentrations and oxygen deficiency as can smoke generators, foggers using highly toxic pesticides and some volatile sprays.

Other Protective Clothing

Wear other protective clothing in keeping with requirement on the label.

Working Conditions

Low Concentrations

Canister gas masks may be used when the ambient air contains low concentrations of toxic gases, vapors or particulate matter derived from soil-drench, granular, dust, or foliar spray applications. Pesticides applied in such manner are usually of moderate to low toxicity. The exception includes fensulfothion (Dasanit 15G) which is of high toxicity. However, because it is available as granules, the wearing of a canister gas mask provides protection. Contact your safety supply company for the proper canister selection.

High Concentrations

Use only a self-contained breathing apparatus (e.g. Scott Air Pack) in the following instances when high concentrations are produced. High concentration of toxic gases, vapors or particulate matter can be produced when dispensing extremely or highly toxic pesticides such as when fumigating grain with methyl bromide. Contact your safety supply company for their recommendation.

SPACE FUMIGANTS AND INSECTICIDE SMOKES

General

When using fumigants or insecticide smoke generators, wear appropriate protective clothing to prevent skin and inhalation exposure. After treatment lock the building where the extermination is being performed and post warning signs. Follow instructions on the product label regarding aeration of treated buildings, warehouses, grain storage bins or areas before permitting reentry. **BECOME FULLY AWARE OF THE HEALTH HAZARDS AND TOXIC PROPERTIES OF THE PESTICIDE YOU ARE USING.**

Fumigants

An agriculturalist using methyl bromide, methyl bromide plus chloropicrin or aluminum phosphide to fumigate vaults, warehouses, and grain storage must obtain a permit issued under the Pesticides Act.

To apply for a permit contact the local Pesticide Officer with the Ministry of the Environment.

When handling methyl bromide, do not wear any gloves because these will trap gas close to the skin. A full face respirator with organic vapour canister or positive pressure breathing apparatus must be worn. A second person with personal protective equipment should be assisting during the fumigation.

When handling aluminum phosphide, use of cotton gloves is recommended. A full face mask respirator with an acid gas canister should be worn. A second person with personal protective equipment should be assisting during the fumigation. Always consult the product label.

For further information, obtain *Methyl Bromide Structure Fumigation Procedures* and *Aluminum Phosphide Structure Fumigation Procedures* from the Ministry of the Environment offices.

STORAGE

1. **General Storage:**

   The Ontario Pesticides Act and Regulation 751 requires that all pesticides be kept out of the reach of children, irresponsible persons, pets and livestock. They should be stored in a locked facility away from food for humans and feed for animals. Herbicides should be stored separately from other pesticides to avoid possible contamination.

   Special Storage:

   Schedule 1, 2 and 5 pesticides must be stored in a storage facility which is ventilated to the outside atmosphere. A placard bearing the words "CHEMICAL STORAGE WARNING — AUTHORIZED PERSONNEL ONLY" in block capitals must be affixed to the outside of each entrance. Entry to the storage facility should only be made by the person responsible for the pesticide or with his permission.

2. **Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers.** See also OMAF Factsheet *Farm Storage of Pesticides,* Agdex 607.
3. In areas where flooding has been a frequent occurrence, fertilizers and pesticides must be stored above the known highwater mark to avoid contamination of the flood waters. Contamination of water by these chemicals can and has led to serious health problems affecting humans and domestic animals as well as fish and wildlife.

DISPOSAL OF PESTICIDE CONTAINERS & CONTAMINATED MATERIAL

1. Pesticide containers and any paper or other material used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke and that the smoke is not directed toward buildings, highways, roads, or public outdoors areas.
2. Unrinsed containers can contain as much as 3% of the original formulation. If this amount of toxic pesticide is discarded with the drum it could be dangerous to other people handling it, or to the environment (for example, your water supply). Failure to rinse is also wasteful — why not use that 3% for the purpose for which it was purchased, i.e. to control the pest!

Rinse all empty metal or glass containers three times with water and add washings to the spray tank. Or, use a rinsing device. These rinsers can be used to puncture the bottom of a metal or plastic drum, and to rinse the residue left in the container directly into the spray tank. This procedure takes less than a minute. The rinsed containers should be crushed, buried and covered by at least 50 cm of soil, away from any watercourse or water table.

SPRAYERS

Herbicide sprayers, capable of delivering sufficient litres per hectare for adequate coverage, are satisfactory for applying emulsion-type insecticides. However, if 2,4-D or related herbicides have been used in them, such sprayers will have to be cleaned thoroughly or foliage is apt to be damaged. The detergent recommended should contain ammonia for best results.

For applying the wettable powder formulations, a high-capacity (450 L/ha), high-pressure piston pump sprayer with an agitator is recommended. Keep in mind that the higher the pressure the greater the danger of drift to other crops.

Calibrate your sprayer at least twice during the growing season. The wear on nozzles and other parts will alter the amount of spray delivered at the usual speed and pressure.

For information on calibration, see the current OMAF Publication 75, *Guide to Weed Control.*

APPLICATION BY AIRPLANES OR HELICOPTERS

Aerial applicators must be licensed by the Ontario Ministry of the Environment to apply pesticides. In addition, permits are required from the Ontario Ministry of the Environment under the authority of The Pesticides Act for the application of Schedule 1 and 5 pesticides, and Schedule 2 hormone-type herbicides. The area will be inspected by ministry personnel to ensure safety of application.

It is an offense under the Federal Pest Control Product Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic to honeybees.

Applications should not be made if the wind is blowing. Some drift occurs even on the stillest day and to keep it to a minimum, apply pesticides in the evening or early morning.

Be sure that the product to be used is specified, along with rate of application, in the contract.

PESTICIDE DRIFT

Pesticide drift can leave unwanted residues on adjacent crops, be a hazard to people and livestock nearby, or reduce the amount of material in the target area as to be ineffective. Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by paying attention to:

1. correct calibration and maintenance of spray equipment;
2. correct operation of the equipment;
3. being aware of the toxicity of the pesticide in use; and
4. being aware of the weather conditions.

For more information consult OMAF Factsheet, *Pesticide Drift,* Agdex 607, or Canadex 607, *Pesticides: Effects of Drift and Droplet Size.*

PROTECT HONEYBEES

Honeybees as well as other bees and insects are important pollinators of several field crops including alfalfa, canola, clover, and trefoil. These pollinators are critical to maximizing seed production. Some crops such as canola and legumes are important sources of honey; while these crops and corn are important pollen sources for bees.

Insecticides, many of which kill bees, are required for insect control. With careful management, you can obtain good insect control without killing bees. You can protect bees by following these suggestions:

1. Do not apply insecticides while crops are in bloom.
2. Time of treatment is important. In general, daytime treatments, when bees are foraging in the field, are most hazardous. Insecticides applied in the very early mornings or evenings are safest.
3. If there is a risk of honeybees poisoning, try to choose an insecticide that is not highly toxic to the bees (use the pesticide rating in Table 89).

WHEN PLANNING TO APPLY A PESTICIDE, ADVISE LOCAL BEEKEEPERS SO THEY HAVE AN OPPORTUNITY TO MOVE COLONIES OUT OF THE DANGER AREA. YOUR LOCAL AGRICULTURAL REPRESENTATIVE HAS A LISTING OF THE BEEKEEPERS IN YOUR AREA.

SEED TREATMENTS

Seed dressings or treatments are poisonous to man and livestock. Do not inhale the fumes or dust when treating or handling treated seed. Wash all residues of these chemicals from the skin after seed treatment is completed. Chemically treated seed is poisonous. Never feed surplus seed to livestock. Destroy all bags that have held treated seed as recommended in the container disposal section above.

RESIDUES ON CROPS TO BE HARVESTED, FED OR GRAZED

Certain pesticide residues disappear quickly after application; others persist in poisonous form for much longer periods. When crops with persistent residues are fed to livestock the poisons tend to accumulate in the body fat and milking cows will excrete them, or their metabolic products in the milk. Young calves, heifers, and dry cows will store these in body fat and secrete them when they freshen months later. Do not use residues from Thiodan-treated crops for bedding. To avoid residue problems, use (1) the proper chemical, (2) the recommended dosage, and (3) observe the proper interval to harvest.

Table 89. Pesticide Toxicity to Bees

Extremely Toxic

Furadan

Growers and apiarists require close liaison where this material is used.

Highly Toxic

Ambush
Cygon
Cymbush
Decis
diazinon
Guthion
Imidan
Lorsban
malathion
Ripcord

Severe losses may be expected if these materials are used when bees are present at treatment time or within a few days thereafter.

Moderately Toxic

Dylox
Lannate
Thiodan

These can be used around bees if dosages, timing, and methods of application are correct, but should not be applied directly on bees, in the field or at the colonies.

Relatively Non-Toxic

All the fungicides

FORMULATIONS

Pesticides may be in either liquid or solid form.

Liquids	E or EC	— Emulsifiable Concentrate
	F	— Flowable
	L	— Liquid
	LC	— Liquid Concentrate
	SC	— Sprayable Concentrate
	Su	— Suspension
Solids	G	— Granular
	P	— Powder
	SP	— Soluble Powder
	WP	— Wettable Powder
	W	— Wettable

Table 90. Seed treatments

Trade Name	Active Ingredient	Formulation[1]	Ontario Schedule[2]
Fungicides			
Agrox N-M	maneb	P(DB)	3
Agrox flowable	maneb	F	3
Anchor	carbathiin + thiram	F(DB)	2
Busan 30	TCMTB	EC	2
Captain Flowable	captan	F	2
Co-op N M	maneb	P(DB)	3
Vitaflo-250	carbathiin	F	3
Vitaflo-280	carbathiin + thiram	F	3
Vitavax Powder	carbathiin + thiram	P(DB)	2
Fungicides with Insecticides			
Agrox B-3	diazinon + lindane + captan	P(DB)	2
Agrox D-L Plus	diazinon + lindane + captan	P(DB)	2
Co-op D-L + C	diazinon + lindane + captan	P(DB)	2
Captan 30-Methoxychlor 3	captan + methoxychlor	F	2
Co-op N M Dual Purpose	maneb + lindane	P(DB)	3
DCT	diazinon + captan + thiophanate-methyl	P(DB)	3
Drillbox D-L + C	diazinon + lindane + captan	P(DB)	2
Drillbox Lindasan	captan + lindane	P(DB)	2
Mergamma N-M	maneb + lindane	P(DB)	2
Methoxychlor 3 (flowable)	captan + methoxychlor	F	2
Polyram-Diazinon	diazinon + metiram	P	3
Rovral ST	iprodione + lindane	F	2
Vitaflo Dual Purpose	carbathiin + thiram + lindane	F	2
Vitavax Dual Powder	carbathiin + thiram + lindane	P(DB)	2
Vitavax RS Flowable	carbathiin + thiram + lindane	P(DB)	3

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[1] *EC (Emulsifiable Concentrate); F (Flowable); P (Powder); DB (Drill Box Application).*

[2] *The numbers identify the Schedules in which the TRADE NAME products listed in this Table are classified under the Pesticides Act. See Table 92 for explanation of schedules.*

Table 91. Fungicides

Trade Name & Formulation (active ingredient)	Fungicide Classification	Days to Harvest	Relative Toxicities[1]	Aerial Application	Distributors	Use and Remarks	Ontario Schedule[2]
Bayleton 50WP (triadimefon)	triazole	60	Low	No	Van Waters & Rogers	hard red, soft white winter wheat	1
Benlate 50W (benomyl)	benzimidazole	14	Low	Yes	Bartlett Chipman May & Baker U.A.P. Van Waters & Rogers	field beans	3
Botran 75W (dichloran)	nitroaniline	2	Low	Yes	U.A.P.	field beans	3
Dithane M45 (mancozeb)	dithiocarbamate	40	Low	Yes	Bartlett U.A.P.	spring and winter wheat	3
Easout 70W (thiophanate-methyl)	benzimidazole	14	Low	Yes	Ciba-Geigy	field beans	3
Rovral 50W (iprodione)	dicarboximide	14	Low	Yes	Bartlett May & Baker UCO	field beans	3
Tilt 250E (propiconazole)	triazole	45	Low	No	Ciba-Geigy	wheat and spring barley	5

W or WP (Wettable Powder); E (Emulsifiable Concentrate).

[1] *See Pesticides Section, Relative Toxicity to Applicator.*

[2] *The numbers identify the Schedules in which the TRADE NAME products listed in this Table are classified under the Pesticides Act. See Table 92 for explanation of schedules.*

Table 92. Explanation of Schedules, Provincial Classification of Pesticides

Ontario Schedule	Explanation of Schedule
Schedule 1	Restricted. Use permit only.
Schedule 2	Restricted to agriculturalists, licensed exterminators and registered custom sprayers.
Schedule 3	May be available for "Domestic" purposes if so registered.
Schedule 4	"Domestic" products only.
Schedule 5	Limited to application by an agriculturist.
Schedule 6	Similar to schedule 4 but may be registered for agricultural/commercial use.

For further information on the regulatory aspects of the classification, please contact the Ministry of the Environment office nearest you.

Table 93. Insecticides

Trade Name & Formulation (active ingredient)	Insecticide Classification	Days to Harvest	Relative Toxicities[1]	Aerial Application	Distributors	Use and Remarks	Ontario Schedule[2]
Ambush 500 EC (permethrin)	pyrethroid	Not after 5-leaf stage	Moderate	No	Chipman UCO	Corn	(3)
Bactospiene (*bacillus thuringiensis*)	Bacterial toxin	0	Low	Yes	Bartlett May & Baker U.A.P.	Seed Corn	(3)
Basudin 50 W (diazinon)	organo phosphorus	14	Moderate	Yes	Ciba-Geigy	Alfalfa, corn, field beans, peas. Toxic to bees.	(2)
Counter 15 G, 5G (terbufos)	organo phosphorus	planting time only	Extreme	No	Cyanamid	Corn Canola	(5)
Cygard 15-G (terbufos + phorate)	organo phosphorus	planting time only	Extreme	No	Cyanamid	Corn	(5)
Cygon 480 E (dimethoate)	organo phosphorus	2 Alfalfa 7 Beans	Moderate	Yes	Bartlett Chipman May & Baker Cyanamid UCO	Alfalfa, field beans. Toxic to bees.	(2)
Cymbush 250 EC (cypermethrin)	pyrethroid	30 Canola 5 Corn	Moderate	No	Chipman	Corn, canola	(2)
Dasanit 15 G (fensulfothion)	organo phosphorus	planting time	Extreme	No	May & Baker U.A.P., UCO	Corn	(2)
Decis 2.5 EC (deltamethrin)	pyrethroid	14	Moderate	No	May & Baker	Canola	(2)
Diazinon 50 W (diazinon)	organo phosphorus	14	Moderate	Yes	Bartlett Chipman May & Baker U.A.P.	grasshoppers	(2)
Dipel SC (*Bacillus thuringiensis*)	Bacterial toxin	0	Low	Yes	May & Baker	Timothy	(3)
Di-Syston 15 G, 720 LC (disulfoton)	organo phosphorus	planting time only	Extreme	No	May & Baker U.A.P. Van Waters & Rogers	Corn	(5)
Dyfonate 20 G (fonofos)	organo phosphorus	planting time only	Extreme	No	Chipman UCO, U.A.P.	Corn	(5)
Dylox 80% SP, 420 Liquid (trichlorfon)	organo phosphorus	21	Low	Yes	May & Baker	Canola, cereals. Relatively safe to bees.	(3)
Furadan 10 G, CR-10 G, 480 F (carbofuran)	carbamate	planting time only 7	Extreme	Yes Permit Required	Bartlett May & Baker UCO U.A.P. Van Waters & Rogers	Corn Canola Alfalfa Toxic to bees.	(2) (Granular) (5) (Flowable)

(Continued on Page 82)

Table 93. Insecticides (Cont.)

Trade Name & Formulation (active ingredient)	Insecticide Classification	Days to Harvest	Relative Toxicities[1]	Aerial Application	Distributors	Use and Remarks	Ontario Schedule[2]
Guthion 240 SC (azinphos-methyl)	organo phosphorus	3 Beans 21 Alfalfa 30 Grain	Extreme	Yes Permit Required	Bartlett May & Baker U.A.P.	Field beans, soybeans. Toxic to bees.	(5)
Imidan 50 W (phosmet)	organo phosphorus	7	Moderate	Yes	Bartlett Chipman	Alfalfa. Toxic to bees.	(3)
Lannate L. (methomyl)	carbamate	21	Extreme	Yes	May & Baker U.A.P. Van Waters & Rogers	Grain	(2)
Lorsban 4 E, 15 G (chlorpyrifos)	organo phosphorus	70	Moderate	Yes Permit Required	U.A.P.	Corn	(3)
Malathion 500 EC, 25 W (malathion)	organo phosphorus	7	Low	Yes	Bartlett May & Baker U.A.P. UCO	Alfalfa, grain crops, field beans soybeans. Toxic to bees. Less effective below 16°C	(3)
Ripcord 400 EC (cypermethrin)	pyrethroid	30	Moderate	No	Ciba-Geigy	Canola Corn	(2)
Thimet 15 G (phorate)	organo phosphorus	planting time only	Extreme	No	Cyanamid	Corn	(2)
Thiodan 4 EC (endosulfan)	organo chlorine	2	Moderate	Yes	Chipman May & Baker U.A.P., UCO	Field beans, soybeans. Toxic to bees.	(2)
Thuricide HPC (*Bacillus thuringiensis*)	Bacterial toxin	0	Low	Yes	Chipman	Timothy	(3)

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[1] *See Pesticides Section, Relative Toxicity to Applicator.*

[2] *The numbers identify the Schedules in which the TRADE NAME products listed in this Table are classified under the Pesticides Act. See Table 92 for explanation of schedules.*

Table 94. Distributors of Pesticides Recommended in Publication 296

Bartlett Inc. 931 Bartlett Road Beamsville, Ont. L0R 1B0	416-563-8261
Chipman 400 Jones Road, P.O. Box 9910 Stoney Creek, Ont. L8G 3Z1	416-643-4123
Ciba-Geigy Can. Ltd. 1200 Franklin Boulevard Cambridge, Ont. N1R 6T5	519-623-7600
Cyanamid Canada Inc. 88 McNabb St. Markham, Ontario L3R 6E6	416-470-3600
May and Baker Canada Inc. 2000 Argentia Road, Plaza 3, Suite 400 Mississauga, Ont. L5N 1V9	416-821-4450
United Agri Products (U.A.P.) 1 Wilton Grove Rd. P.O. Box 22116 London, Ontario N6C 4N0	519-681-2173
United Cooperatives of Ontario P.O. Box 527, Station A Mississauga, Ont. L5A 3A4	416-270-3560
Van Waters & Rogers 1020 Hargrieve Road, Unit D London, Ontario N6E 1P5	519-668-3007

GENERAL INFORMATION

SEEDING INFORMATION

Crop	Seeding Rate kg/ha	Seed Weight kg/hl	Seed Weight lb/bu
Wheat (Winter & Spring)	100-130	75	60
Oats	60-110	42	34
Barley (Winter & Spring)	80-160	60	48
Rye	70-95	70	56
Triticale	75-100	65	52
Corn (Field)	11-22	70	56
White Beans (70 cm rows)	40-45	75	60
Soybeans	65-155	75	60
Peas (Field)	130-200	75	60
Buckwheat	55	60	48
Flax	40	70	56
Canola (Spring & Winter)	4-5	62	50
Millet (Proso)	40	70	56
Sunflower, oilseed	4	34	27
stripes	6	30	24
Mustard (Yellow)	8-11	70	56
Sudangrass	14	50	40
Sorghum	14	70	56
Annual canarygrass	35	62	50

DISTRIBUTORS OF VARIETIES RECOMMENDED IN PUBLICATION 296

Agri Seed Ltd. Box 1415, Chatham, Ontario N7M 5W8	519-354-7251
Aishling Farm Seeds R.R.#2, Baltimore, Ontario K0K 1C0	416-372-5359
Allelix Inc. 6850 Goreway Drive, Mississauga, Ontario L4V 1P1	416-677-0831
Bishop Farm Seeds Limited Box 338, Belleville, Ontario K8N 5A5	613-968-5533
Bonis & Co. Ltd. P.O. Box 217, Lindsay, Ontario K9V 5Z4	705-324-0544
C & M Seeds R.R. #3, Palmerston, Ontario N0G 2P0	519-343-2126
Cargill Hybrid Seeds Box 490, Princeton, Ontario N0J 1V0	519-458-4336
Cargill Grain Co. Ltd. P.O. Box 490, Chatham, Ontario N7M 5K6	519-352-1300
Dekalb Canada Inc. Box 430, Chatham, Ontario N7M 5K5	519-352-5310
Ferguson Seeds R.R. #1, Essex, Ontario N8M 2X5	519-776-5779
First Line Seeds R.R. #2, Guelph, Ontario N1H 6H8	519-821-0882
Funk Seeds Ciba-Geigy Canada Limited R.R. #3, Cottam, Ontario N0R 1B0	519-839-4851
Jacques Canada Limited P.O. Box 598, Niagara Falls, Ontario L2E 6V2	1-800-843-5362
King Agro P.O. Box 1088, Chatham, Ontario N7M 5L6	519-354-3210
Labonté Seeds Limited Box 1660, New Liskeard, Ontario P0J 1P0	705-647-6821
Mapleseed Inc. Oakwood, Ontario K0M 2M0	705-786-2020
Northrup Kings Seeds Limited 1250 Franklin Boulevard, Box 1207 Cambridge, Ontario N1R 6C9	519-621-0890
Oseco Inc. P.O. Box 219, Brampton, Ontario L6V 2L2	416-846-5080
Heritage Seeds 75 Cardigan Street, Guelph, Ont. N1H 3Z7	519-822-4800
Otto Pick & Sons Seeds Limited (Pickseed) Box 126, Richmond Hill, Ontario L4C 4X9	416-884-1147
Pioneer Hi-Bred Limited Box 730, Chatham, Ontario N7M 5L1	519-352-6350
Pride Brand Seeds P.O. Box 1088, Chatham, Ontario N7M 5L6	519-354-3210

(Continued on Page 84)

DISTRIBUTORS OF VARIETIES RECOMMENDED IN PUBLICATION 296

Rothwell Seeds Limited Box 511, Lindsay, Ontario K9V 4L9	705-324-9591
SeCan Association* Suite 512, 885 Meadowlands Drive Ottawa, Ontario K2C 3N2	613-225-6891
Speare Seeds Limited P.O. Box 171, Harriston, Ontario N0G 1Z0	519-338-3840
Tib Szego Associates Limited P.O. Box 366, Lindsay, Ontario K9V 4S3	705-324-0042
United Cooperatives of Ontario 151 City Centre Drive Mississauga, Ontario L5A 3A4	416-270-3560
W.G. Thompson & Sons Limited Box 250, Blenheim, Ontario N0P 1A0	519-676-5411

**SeCan is an association of seed growers and seed companies which handles the release and promotion of publicly developed varieties. For more information on these varieties, contact your local SeCan member.*

ONTARIO MINISTRY OF AGRICULTURE AND FOOD

County	OMAF Offices		Soils and Crops Specialists	
Essex	46 Fox St., Essex N8M 2S2	519-776-7361	Henry Olechowski c/o RCAT, Ridgetown N0P 2C0	519-674-5456
Kent	Box 726, 435 Grand Ave. W. Chatham N7M 5L1	519-354-2150		
Lambton	Box 730, 360 Highway #21, Petrolia N0N 1R0	519-882-0180	Peter Johnson 50 King St., London N6A 2P2	519-434-6811
Middlesex	50 King St., London N6A 2P2	519-434-6811		
Oxford	Box 666, Woodstock N4S 7Z5	519-537-6621	Hugh Martin 9 Gladstone Ave., St. Thomas N5R 2L3	519-631-4700
Elgin	9 Gladstone Ave., St. Thomas N5R 2L3	519-631-4700		
Norfolk	Box 587, Simcoe N3Y 4N5	519-426-7120	Henriette Plas Box 587, Simcoe N3Y 4N5	519-426-7120
Brant	207 Greenwich St., Brantford N3S 2X7	519-759-4190		
Wentworth	R.R. 1, Ancaster L9G 3K9	416-527-2995		
Huron	Box 159, Clinton N0M 1L0	519-482-3428	John Heard Box 398, 413 Hibernia St. Stratford N5A 6T3	519-271-0280
Perth	Box 398, 413 Hibernia St. Stratford N5A 6T3	519-271-0280		
Haldimand	Box 129, Cayuga N0A 1E0	416-772-3381	Jerry Winnicki 726 Canboro Rd Fenwick L0S 1C0	416-892-4741
Niagara North	Advisory Services Bldg., OMAF Vineland Station L0R 2E0	416-562-4147		
Niagara, South	726 Canboro Rd. Fenwick L0S 1C0	416-892-4741		

Wellington	R.R. 1, Fergus N1M 2W3	519-846-0941	Harvey Wright c/o Crop Science University of Guelph, Guelph N1G 2W1	519-824-4120 Ext. 6763
Waterloo	279 Weber St., N. Waterloo N2J 3H8	519-884-5390		
Halton	17 Wilson Dr., Milton L9T 3J7	416-878-2314		
Bruce	Box 1330, Walkerton N0G 2V0	519-881-3301	Joan McKinlay 181 Toronto St. S. Markdale N0C 1H0	519-986-2040
Grey	181 Toronto St. S. Markdale N0C 1H0	519-986-2040		
Dufferin	R.R. 4, Orangeville L9W 2Z1	519-941-3830		
Simcoe, North	Box 340, Elmvale L0L 1P0	705-322-2231	Dave Morris Box 370, Alliston L0M 1A0	705-435-5521
Simcoe, South	Box 370, Alliston L0M 1A0	705-435-5521		
Peel	35 Van Kirk Dr., Unit 9 Brampton L7A 1A5	416-451-5474		
York	Newmarket Plaza Newmarket L3Y 1N1	416-895-4519		
Durham West	Box 309, Uxbridge L0C 1K0	416-852-3328	Neil Moore 322 Kent St. W Lindsay K9V 2Z9	705-324-6125
Victoria-Haliburton	322 Kent St. W. Lindsay K9V 2Z9	705-324-6125		
Durham East	234 King St. E. Bowmanville L1C 1P5	416-623-3348	Jack Kyle 322 Kent St. W. Lindsay K9V 2Z9	705-324-6125
Peterborough	55 George St. N. Peterborough K9J 3G2	705-745-2403		
Northumberland	Box 820, Brighton K0K 1H0	613-475-1630		
Hastings	Box 340, Stirling K0K 3E0	613-395-3393	Stephen Clare Box 470 Picton K0K 2T0	613-476-3224
Lennox & Addington	41 Dundas St. W. Napanee K7R 1Z5	613-354-3371		
Prince Edward	Box 470, Picton K0K 2T0	613-476-3224		
Frontenac	Box 651, 1055 Princess St. Kingston K7L 4X1	613-545-4360		
Leeds	Box 635, Brockville K6V 5V8	613-342-2124	Gilles Quesnel Box 2004 Kemptville K0G 1J0	613-258-8304
Grenville	Box 2004, Kemptville K0G 1J0	613-258-8298		
Dundas	Box 488, Winchester K0C 2K0	613-744-2313		
Stormont	Box 97, Avonmore, K0C 1C0	613-346-2143		
Lanark	10 Sunset Blvd, Perth K7H 2Y2	613-267-1063	Paul Sullivan 26 Thorncliff Place Nepean K2H 6L2	613-828-9167
Renfrew	315 Raglan St. S. Renfrew K7V 1R6	613-432-4841		
Carleton	26 Thorncliff Place Nepean K2H 6L2	613-828-9167		
Prescott	Box 110, Plantagenet K0B 1L0	613-673-5115	Paul Beaudin Box 110 Plantagenet K0B 1L0	613-673-5115
Russell	Box 540, 666 Notre Dame St. Embrum K0A 1W0	613-443-3391		
Glengarry	Box 579, St. George St. E Alexandria K0C 1A0	613-525-1046		

ONTARIO MINISTRY OF AGRICULTURE AND FOOD

Northern Ontario District Offices

District	OMAF Offices		Soils and Crops Specialists	
Algoma	1496 Wellington St. E. Sault Ste. Marie P6A 2R1	705-253-1161	Daniel Tassé 222 McIntyre St. W. North Bay P1B 2Y8	705-474-3050
Cochrane N.	Experimental Farm Kapuskasing P5N 2X9	705-335-5828		
Cochrane S.	Box 608, Matheson P0K 1N0	705-273-2509		
Kenora	Ontario Government Building Box 3000, Dryden P8N 3B3	807-223-2415		
Manitoulin	Box 328, Gore Bay P0P 1H0	705-282-2043		
Muskoka & Parry Sound	Box 130, 8 Centre St. N. Huntsville P0A 1K0	705-789-8886		
Nipissing	222 McIntyre St. W. North Bay P1B 2Y8	705-474-3050		
Rainy River	Front St., Emo P0W 1E0	807-482-2310		
Sudbury	1899 LaSalle Blvd. Sudbury P3A 2A3	705-566-1630		
Timiskaming	Box "G" New Liskeard P0J 1P0	705-647-6701		
Thunder Bay	Ontario Government Building 435 James St. S. Thunder Bay P7E 6E3	807-475-1631		

Tobacco Specialists

Milt Watson, Norm Sheidow*, Research Station, Box 186, Delhi N4B 2W9 *on work assignment until June 1989	519-582-1950

Pasture Specialist

Susan Robinson, Box 340, Stirling K0K 3E0	613-395-3393

Insect and Disease Specialists

Insects	Karl Bereza, R.R. 1, Ancaster L9G 3K9	416-527-2295
Diseases	Craig Hunter, Research Station, P.O. Box 587, Simcoe N3Y 4N5	519-426-7120

Feed Crop Specialist

Ken Hough, c/o Crop Science, University of Guelph, Guelph N1G 2W1	519-824-4120 Ext. 3410

ONTARIO MINISTRY OF THE ENVIRONMENT — PESTICIDES CONTROL FIELD OFFICES

Counties	Field Offices	Telephone
Southwestern Region		
Elgin, Middlesex, Oxford	985 Adelaide Street South, London N6E 1V3	519-661-2200
Essex, Kent, Lambton	P.O. Box 726, 435 Grand Avenue West, Chatham N7M 5L1	519-354-2150
Bruce Grey, Huron, Perth	20 King Street, P.O. Box 688 Ontario Ministry of Agr. & Food Bldg., Clinton N0M 1L0	519-482-3428
West Central Region		
Haldimand, Norfolk, Niagara Hamilton, Wentworth Dufferin, Wellington, Waterloo, Brant	Ontario Government Building 119 King Street West, Hamilton L8N 3Z9	416-521-7640
Central Region		
Halton, Peel, York, Durham, Toronto, Simcoe, Muskoka	7 Overlea Boulevard, 4th Floor, Toronto M4H 1A8	416-424-3000
Peterborough, Victoria Haliburton, Northumberland	139 George Street N., Peterborough K9J 3G6	705-743-2972
Southeastern Region		
Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville	133 Dalton Street, P.O. Box 820, Kingston K7L 4X6	613-549-4000
Prescott & Russell, Renfrew, Stormont, Dundas & Glengarry, Ottawa-Carleton, Lanark	2378 Holle Lany, Suite 204, Ottawa K1V 7P1	613-521-3450
Northeastern Region		
Manitoulin, Nipissing, Parry Sound, Sudbury, Cochrane, Timiskaming, Algoma	199 Larch Street, Sudbury P3E 5P9	705-675-4501
Northwestern Region		
Kenora, Rainy River, Thunder Bay	Ontario Government Building 435 James Street S., Thunder Bay P7C 5G6	807-475-1215
Head Office		
Hazardous Contaminants Co-ordination Branch	Pesticides Section, HCCB, 135 St. Clair Avenue W., Suite 100, Toronto M4V 1P5	416-323-5095
Pesticide Licencing & Examination Section	Approvals Branch 3rd floor, 250 Davisville Avenue Toronto, Ontario M4S 1H2	416-440-3713

PUBLICATIONS —
The following publications are available from any of the Pesticide Control Field Offices or from the Head Office of the Ministry of the Environment:

Personal Protective Equipment for Pesticide Users
Chemical Safety Handbook
Pesticides Act and Regulations
Chemical-Storage Signs

PUBLICATIONS

Available from your local office of the Ontario Ministry of Agriculture and Food

CORN

Corn Production in Ontario — Publication 13
1989 Ontario Hybrid Corn Performance Trials Report

Factsheets:

111/31	*Heat Units for Corn in Southern Ontario*
111/61	*High Moisture Corn*
100/531	*Zinc Requirements for Field Crops*
111/541	*Nitrogen Recommendations for Corn*
111/542	*Nitrogen Fertilizer Materials*
111/622	*European Corn Borer*
111/622	*Corn Leaf Aphid*
111/622	*Corn Rootworms*
111/622	*Potato Stem Borer in Field Corn*
111/630	*Stunting of Young Corn*
111/632	*Leaf Diseases of Field Corn*
111/736	*Harvesting and Storing Quality Grain Corn*
111/736	*Natural Air Corn Drying Systems*
111/742	*Calibrating Your Corn Planter*
111/745	*Measuring Corn Harvesting Losses*
111/840	*Pricing Corn in Ontario*
440/60	*Moldy Feeds and Swine Diseases*
610	*Slugs*

FORAGES

Alfalfa — Publication 59
Pasture Production — Publication 19
Quality Forage for Milk or Beef — Publication 54
Annuals for Supplementary Feed — Publication 47
Pasture Grasses Identified — Publication 204
Red Clover for Feed, Seed and Soil — Publication 221

Factsheets:

120/52	*Quality Hay Crop Silage*
120/81	*Protein Supplements from Forage Legumes*
120/30	*Fertilizer Use in Forage Establishment*
120/622	*European Skipper*
120/732	*Big Bale Hay Storage*
120/736	*Harvesting and Storing Big Bale Haylage*
120/736	*Barn Hay Drying*
120/745	*Haying with a Large Round Baler*
121/21	*Alfalfa Persistence*
121/21	*Establishment of Bird's-Foot Trefoil*
121/531	*Boron Requirements for Alfalfa*
121/542	*Fertilizer Practices for Alfalfa Production*
121/600	*Verticillium Wilt of Alfalfa*
121/622	*Alfalfa Weevil*
121/622	*Early Warning System for Alfalfa Weevil Management*
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122	*Producing Red Clover Seed in Ontario*
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122/10	*Red Clover in Ontario*
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122/22	*Establishment of Bird's-Foot Trefoil*
130	*Pasture Legumes Identified*
130/643	*Common Weeds Poisonous to Grazing Livestock*
130/643	*Poisoning of Livestock by Plants*
133	*Annual Forages for Pasture*
136/22	*Pasture Renovation*
460/10	*Hay and Pasture for Horses*

CEREAL GRAINS

Rid Ontario of Common Barberry and European Buckthorn — Publication 49
Insects in Farm Stored Grain — Publication 229
1988 Regional Test Report Barley, Oats, and Wheat, Department of Crop Science, University of Guelph

Factsheets:

100/531	*Manganese In Soybean and Small Grain Production*
110/622	*Armyworms*
110/632	*Yellow Dwarf of Cereals*
110/717	*Grain Aeration*
112/630	*Root, Crown and Basal Stem Diseases of Winter Wheat*
112/630	*Head Diseases of Winter Wheat*
112/600	*Leaf Diseases of Winter Wheat*
113/632	*Oat-Cyst Nematode*
114/532	*Fertilizing Practices for Growing Spring Barley*
114/632	*Leaf and Head Diseases of Barley*
118/10	*Winter Triticale In Ontario*
516/742	*No Till Grain Drills*

FIELD BEANS

Factsheets:

140/10	*Coloured Beans in Ontario*
140/630	*Virus Diseases and Bronzing of Field and Snap Beans*
142	*Growing White Beans in Ontario*
142/622	*White Bean Insects*
142/632	*Common Blight of Field Beans*
255/630	*Fungal Diseases of Field and Snap Beans*

FIELD PEAS

Factsheets:

142/13	*Field (Dry) Peas in Ontario*

SOYBEANS

Soybean Production — Publication 173
1989 Report, Ontario Soybean Variety Trials

Factsheets:

100/531	*Manganese in Soybean and Small Grain Production*
141/632	*Virus Diseases of Soybeans*
141/745	*Measuring Soybean Harvesting Losses*
141/840	*Pricing and Marketing Soybeans*

FLAX

148/10	*Flax in Ontario*

CANOLA

149/10	*Spring Canola in Ontario*

HERBICIDES AND WEEDS

Guide to Weed Control — Publication 75
Ontario Weeds — Publication 505 Price $5.00

Factsheets:

744	*Weed Sprayer Calibration*
100/744	*Calibration of Flood-Jet Nozzles*
607	*Pesticide Drift*
640	*Cocklebur*
640	*The Annual Nightshades*
640	*Proso Millet*
642	*Coltsfoot*
642	*Field Bindweed*
642	*Jerusalem Articoke*
642	*Pigweeds (Redroot, Green and Smooth)*
642	*Wild Mustard*
642	*Wirestem Muhly*
641	*Long-Term Weed Control Planning*
130/643	*Common Weeds Poisonous to Grazing Livestock*

SOILS

Ontario Soils — Publication 492
Windbreaks on the Farm — Publication 527

Factsheets:

100/516	*Tillage for Crop Production on Ontario Soils — Practices*
100/516	*Tillage for Crop Production on Ontario Soils — Principles*
100/531	*Zinc Requirements for Field Crops*
100/536	*Tillage Practices for Residue Management and Erosion Control*
100/540	*Foliar and Liquid Fertilizers*
100/541	*How and Where to Use Sewage Sludge in Crop Production*
510	*The Chisel Plow*
510	*Soil Compaction*
516/13	*The Moldboard Plow*
534	*Soil Acidity and Liming*
538	*Manure Characteristics*
540	*Chemical and Organic Fertilizers*
554	*Surface Drainage*
555	*Management of Drained Fields*
555	*Mutual Agreement Drains*
555	*Drainage Benefits*
562	*Irrigation — Water Supply*
572	*Soil Erosion — Causes and Effects*
573	*Grassed Waterways*
573	*Gulley Erosion Control*
573	*Control of Soil Erosion*

PESTICIDE USE

Factsheets:

606	*Soil Fumigants*
607	*Storing Pesticides on the Farm*
607	*Pesticide Contamination of Farm Water Supplies*
607	*Pesticide Container Rinsing*

AVAILABLE FROM ONTARIO MINISTRY OF THE ENVIRONMENT FIELD OFFICES

Personal Protective Equipment for Pesticide Users
Chemical Safety Handbook
Pesticides Act and Regulations
Chemical Storage Signs

AVAILABLE FROM INFORMATION SERVICES, AGRICULTURE CANADA, OTTAWA K1A 0C7

Growing and Managing Alfalfa in Canada — Publication 1705E
Ergot of Grains and Grasses — Publication 1438E
Insects and Mites in Farm-Stored Grain — Publication 1595E

AVAILABLE FROM CANADIAN SEED GROWERS ASSOCIATION, BOX 8455, OTTAWA, ONTARIO K1G 3T1

Pedigreed Forage Seed Production
Rogues and Roguing Cereal Crops

METRIC INFORMATION

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetre (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

Square Measures (area)

100 m × 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight-Volume Equivalents (for water)

(1.00 kg) 1000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

Weight Measures

100 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dry-Liquid Equivalents

1 cm^3 = 1 mL
1 m^3 = 1000 L

APPROXIMATE APPLICATION RATE CONVERSIONS

Metric to Imperial

litres per hectare × 0.09 = gallons per acre
litres per hectare × 0.36 = quarts per acre
litres per hectare × 0.71 = pints per acre
millilitres per hectare × 0.015 = fluid ounces per acre
grams per hectare × 0.015 = ounces per acre
kilograms per hectare × 0.89 = pounds per acre
tonnes per hectare × 0.45 = tons per acre

Imperial to Metric

gallons per acre × 11.23 = litres per hectare (L/ha)
quarts per acre × 2.8 = litres per hectare (L/ha)
pints per acre × 1.4 = litres per hectare (L/ha)
fluid ounces per acre × 70 = millilitres per hectare (mL/ha)
tons per acre × 2.24 = tonnes per hectare (t/ha)
pounds per acre × 1.12 = kilograms per hectare (kg/ha)
ounces per acre × 70 = grams per hectare (g/ha)

Dry-Weight Equivalents

Grams or Kilograms per Hectare		Approximate Ounces or Pounds per Acre
100 grams	=	1½ ounces
200 grams	=	3 ounces
300 grams	=	4¼ ounces
500 grams	=	7 ounces
700 grams	=	10 ounces
1.10 kilograms	=	1 pound
1.50 kilograms	=	1¼ pounds
2.00 kilograms	=	1¾ pounds
2.50 kilograms	=	2¼ pounds
3.25 kilograms	=	3 pounds
4.00 kilograms	=	3½ pounds
5.00 kilograms	=	4½ pounds
6.00 kilograms	=	5¼ pounds
7.50 kilograms	=	6¾ pounds
9.00 kilograms	=	8 pounds
11.00 kilograms	=	10 pounds
13.00 kilograms	=	11½ pounds
15.00 kilograms	=	13½ pounds

Liquid Equivalents

Litres/Hectare		Approximate Gallons/Acre
50	=	5
100	=	10
150	=	15
200	=	20
250	=	25
300	=	30

CONVERSION TABLES

METRIC TO IMPERIAL

Length

1 millimetre (mm) = 0.04 inch
1 centimetre (cm) = 0.40 inch
1 metre (m) = 39.40 inches
1 metre (m) = 3.28 feet
1 metre (m) = 1.09 yards
1 kilometre = 0.62 mile

Volume (liquid)

1 millilitre (mL) = 0.035 fluid ounce
1 litre (L) = 1.76 pints
1 litre (L) = 0.88 quart
1 litre (L) = 0.22 gallon (Imperial)
1 litre (L) = 0.26 gallon (U.S.)

Weight

1 gram (g) = 0.035 ounce
1 kilogram (kg) = 2.21 pounds
1 tonne (t) = 1.10 short tons
1 tonne (t) = 2205 pounds

Pressure

1 kilopascal (kPa) = 0.15 pounds/square inch

Area

1 square centimetre (cm^2) = 0.16 square inch
1 square metre (m^2) = 10.77 square feet
1 square metre (m^2) = 1.20 square yards
1 square kilometre (km^2) = 0.39 square mile
1 hectare (ha) = 107,636 square feet
1 hectare (ha) = 2.5 acres

Volume (dry)

1 cubic centimetre (cm^3) = 0.061 cublic inch
1 cubic metre (m^3) = 1.31 cubic yards
1 cubic metre (m^3) = 35.31 cubic feet
1000 cubic metres (m^3) = 0.81 acre-foot
1 hectolitre (hL) = 2.8 bushels

Speed

1 metre per second = 3.28 feet per second
1 metre per second = 2.24 miles per hour
1 kilometre per hour = 0.62 mile per hour

Temperature

°F = (°C × 9/5) + 32
°C = (°F −32) × 5/9

IMPERIAL TO METRIC

Length

inch = 2.54 cm
foot = 0.30 m
yard = 0.91 m
mile = 1.61 km

Area

square foot = 0.09 m^2
square yard = 0.84 m^2
acre = 0.40 ha

Weight

ounce = 28.35 g
pound = 453.6 g
ton = 0.91 tonne

Volume (dry)

cubic yard = 0.76 m^3
bushel = 36.37 L

Volume (liquid)

fluid ounce (Imp.) = 28.41 mL
pint (Imp.) = 0.57 L
gallon (Imp.) = 4.55 L
gallon (U.S.) = 3.79 L

Pressure

pound per square inch = 6.90 kPa

EMERGENCY AND FIRST AID PROCEDURES FOR PESTICIDE POISONING

Become familiar with the chemicals you are using. Keep a list of common names in case of accidents or emergencies. This information can be found on the product labels and cross-referenced in this publication.

If a pesticide has come in contact with the skin or has been spilled on clothing, remove the clothing and wash the skin thoroughly with soap and warm water.

If a pesticide has come in contact with the eyes, rinse them with plenty of clean water.

If a person suspects poisoning from exposure to a pesticide by swallowing, inhalation, or contact with skin or eyes, read the label on the pesticide container and carry out the first-aid treatment suggested.

IMMEDIATELY AFTER THE FIRST-AID TREATMENT HAS BEEN GIVEN, WRAP THE PATIENT IN A COAT OR BLANKET AND RUSH HIM TO THE NEAREST HOSPITAL. TAKE THE LIST OF CHEMICAL COMMON NAMES WITH YOU AND IDENTIFY THE ONES BEING USED.

IF A PERSON IS FOUND UNCONSCIOUS OR LAPSES INTO UNCONSCIOUSNESS, CALL AN AMBULANCE IMMEDIATELY.

EMERGENCY ADVICE ON PESTICIDE POISONING IS AVAILABLE BY CONTACTING THE POISON INFORMATION CENTRES. THE NAMES AND TELEPHONE NUMBERS ARE LISTED UNDER EMERGENCY CALLS AT THE FRONT OF EACH BELL TELEPHONE DIRECTORY.

FILL IN THE FOLLOWING:

MY LOCAL POISON INFORMATION CENTRE TELEPHONE NUMBER IS _____-_________.

PUBLICATION 296 SUPP.

1990
Supplement

to

Field Crop Recommendations
1989-1990 Edition

Ontario

Ministry of
Agriculture
and Food

David Ramsay, Minister

To the best of the collective knowledge of the members of the Ontario Crop Protection Committee, all pesticides listed in this publication were federally registered, reviewed by the Ontario Pesticides Advisory Committee and classified by the Ministry of the Environment as of November 8, 1989.

The information presented on the pesticide container label regarding application rates and methods of application are the final authority and where conflicts occur between this publication and the container label, the latter applies.

PAY CLOSE ATTENTION TO ALL INSTRUCTIONS AND WARNINGS PRINTED ON THE PESTICIDE LABEL.

The Ministry of Agriculture and Food, or the Ontario Crop Protection Committee by printing this publication does not offer any warranty or guarantee and they do not assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

POLICY STATEMENT

In this publication, most recommendations list several pesticides that are effective for each insect or disease discussed. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first. These are followed by the more toxic pesticides and/or newer ones with which we have less experience. It must be emphasized that, in some cases, the most effective pesticides are highly toxic.

Weather and other factors influence the effectiveness of pesticides and the likelihood of plant injury by control chemicals. Consult the package label and other information regarding compatability with other materials, the effect of high or low temperatures, poor drying conditions, etc. Wettable or soluble powders (WP or SP) generally are less likely to cause plant injury than liquid concentrates (EC, SC, and F).

A number of brand names of pesticides are given in the calendars as a convenience to the grower and are neither an endorsement of the product nor a suggestion that similar products are not effective. The pesticide recommendations are reviewed annually by the Ontario Crop Protection Committee. Health and Welfare Canada has established maximum residue limits (MRL's) for pesticides. However, growers should be aware that processors or retailers may demand different pesticide limits.

For additional information or clarification of recommendations, contact Ontario Ministry of Agriculture and Food personnel listed on pages 84-85 of Publication 296, *1989-1990 Field Crop Recommendations.* Growers should seek advice of their intended market as to which restrictions or limitations are applicable.

FEDERAL REGISTRATION AND PROVINCIAL CLASSIFICATION

Ontario's Pesticides Act and Regulations 751, administered by the Ministry of the Environment, prohibits the sale and use of pesticide products unless they are registered under the federal Pest Control Products Act and classified under the provincial Pesticides Act by being placed in one of six schedules of the Ontario regulation.

FEDERAL REGISTRATION

There are three categories:

1. **Full Registration**

   Implies that all federal departments involved in the registration process agree that the package was acceptable at the time of registration.

2. **Temporary Registration**

   Indicates that there is a need for additional scientific or technical information to acquire a full registration. Temporary registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use in the following year.

3. **Temporary Registration (Restricted Class)**

   Indicates that there is an urgent need for the pesticide but that studies on the safety of the product are incomplete. Such registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use the following year. The pesticide product presently carrying temporary registration (restricted class) and included in this publication is Bayleton (triadimefon). This material may, or may not, be available for use in 1990.

PROVINCIAL CLASSIFICATION

Pesticide products are classified into six schedules in Regulation 751 on the basis of their toxicity, environmental or health hazard, persistence of the active ingredient or its metabolites, concentration and usage. This classification system provides the basis for regulating the distribution, availability and use of pesticide products in Ontario.

For updated information on the regulatory status of these or other pesticides, contact the Pesticides Section, Hazardous Contaminants Coordination Branch, Ministry of the Environment, Toronto, Telephone 416-323-5095.

This supplement complements Publication 296, *1989-1990 Field Crop Recommendations*, but does not replace it. A limited number of copies of that publication are available from your local OMAF office.

This supplement contains those tables on varieties and pesticides that have changes from the 1989-1990 edition of Publication 296. The revised tables are numbered to correspond with the original tables.

Publication 296 will be revised and published for 1991-1992.

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CORN

Hybrid Selection

Information on hybrid corn performance is published in the OMAF Publication, *1990 Ontario Hybrid Corn Performance Trials Report*, available by January each year.

PESTICIDES FOR INSECT CONTROL IN CORN

Table 17. Corn Rootworm Control

		Rate of Product		
Insecticide	**Placement**[1]	**Grams per 100m of any row width**	**kg/ha at Row Width of 90cm**	**75cm**
Counter 15G[2]	Band	75	8.3	10.0
Thimet 15G	Band	75	8.3	10.0
Dyfonate 20G[3]	Band	55	6.1	7.3
Counter 15G[2]	In furrow	75	8.3	10.0
Lorsban 15G	Band	75	8.3	10.0
Cygard 15G	Band	75	8.3	10.0
Di-Syston 15G	Band	75	8.3	10.0
720 LC[4]	Band	15 mL	1.6 L/ha	2.0 L/ha
Furadan 10G	Band	110	12.2	14.6

G (Granular); LC (Liquid concentrate)

Under heavy insect pressures the products divide into three groups of effectiveness. Within groups, products are equally effective and are listed by date of registration.

[1] *Band application - place material in a 15 cm. band ahead of the press wheel. In furrow appplication - place all material directly in the open seed furrow, behind the planter shoe.*

[2] *Also controls seed corn maggot and wireworms.*

[3] *Also controls seed corn maggot.*

[4] *Liquid concentrate must be applied in a 15 cm. band for control. Do not apply with liquid starter fertilizer because the band is not wide enough for control of rootworms.*

Table 18. European Corn Borer Control

Insecticide	**Product per ha**
Cymbush 250 EC	280 mL
Ripcord 400 EC	175 mL
*Furadan 480 F	1.1 L
Sevin XLR PLUS 480 Su[1]	2.5-4.0 L
Bactospiene[2]	2.6 L for seed corn only

EC (Emulsifiable Concentrate); F (Flowable); Su (Suspension).

**Minimum period before reentry is 48 hours.*

[1] Several formulations of Sevin are available for use according to label instructions. Sevin XLR PLUS is recommended because it is less hazardous to bees foraging for corn pollen. Follow precautions applying to honeybees.

[2] Bactospiene is a biologicial insecticide containing an insect toxin produced by the bacterium Bacillus thuringiensis. For effective control applications must be timed for newly hatched larvae. Delayed timing results in poor control. Good leaf coverage is essential to achieve effective control.

Table 19. Cutworm Control[1]

Insecticide	Product per ha
Ambush 500 EC [2]	225-300 mL
Lorsban 4 E	2.4 L
Ripcord 400 EC	175 mL

E or EC (Emulsifiable Concentrate)

[1] Seedling stage only.

[2] Read the label. Do not disturb the soil for 5 days after application.

SOYBEANS

Variety Selection

Information on soybean variety performance is published in the OMAF Publication, *1990 Report, Ontario Soybean Variety Trials*, available in January each year.

FORAGE CROPS

Variety Selection

Table 28. Recommended Alfalfa Varieties

	Yield (% of Saranac)		Disease Reaction[2]			
Variety	S. Ontario	N. Ontario	Verticillium Wilt	Phytophthora Root Rot	Bacterial Wilt	Distributor[1]
Admiral	101	95	R	R	R	First Line Seeds
Advance	104	-	R	S	R	Pickseed
Algonquin	96	102	S	S	HR	Public
Alouette	99	103	S	S	R	Pickseed
Ambassador	104	100	R	R	R	Mapleseed Inc., Pride Brand Seeds
Anchor	99	100	S	S	R	Oseco Inc.
Angus	98	101	S	S	HR	Public
Apica	104	104	S	S	R	United Cooperatives of Ontario
Apollo II	99	95	MR	HR	R	Oseco Inc.
Armor	102	99	S	R	R	Oseco Inc.
Arrow	104	104	R	HR	HR	Pickseed
Award	101	-	S	S	R	Speare Seeds
Bell Ringer	104	-	MR	S	R	King Agro
Centurion	101	100	R	R	HR	United Cooperatives of Ontario
Champion	102	-	MR	MR	R	Parsons Seeds
Chief	103	-	R	HR	HR	Jacques Canada
Citation	102	104	S	S	R	Mapleseed Inc.
Comsel	99	-	S	HR	R	Norcan Seeds, Speare Seeds

(continued on page 4)

Table 28. Recommended Alfalfa Varieties (cont.)

	Yield (% of Saranac)		Disease Reaction[2]			
Variety	**S. Ontario**	**N. Ontario**	**Verticillium Wilt**	**Phytophthora Root Rot**	**Bacterial Wilt**	**Distributor[1]**
Crown	102	102	R	R	R	Cargill Hybrid Seeds
Crusader	100	102	MR	R	HR	Pride Brand Seeds
120	104	104	S	R	HR	Dekalb Canada
DK 125	103	102	R	R	HR	Dekalb Canada
DK 135	102	97	MR	MR	MR	Dekalb Canada
Eagle	100	97	MR	MR	HR	Cargill Hybrid Seeds
Edge	102	103	R	R	R	First Line Seeds
Excalibur	103	103	R	S	R	United Cooperatives of Ontario
Glory	101	101	S	S	R	Speare Seeds
G2852	104	-	R	R	HR	Funk Seeds
Horizon	104	-	HR	HR	HR	Pride Brand Seeds
Hunter	99	99	S	S	R	Rothwell Seeds
Husky	103	103	S	MR	R	Oseco Inc.
Iroquois	99	100	S	S	HR	Public
Magnum	100	101	S	S	HR	Funk Seeds
Magnum +	101	102	S	R	R	Funk Seeds
88	102	99	R	MR	R	Mapleseed Inc.
Mohawk	98	98	S	S	HR	Rothwell Seeds, United Cooperatives of Ontario
Noble	101	-	S	S	R	United Cooperatives of Ontario
OAC Minto	102	103	S	S	R	Speare Seeds, Bishop Seeds
Olinda	100	-	S	HR	R	SeCan member
Oneida VR	101	-	HR	R	R	Pickseed
Peak	101	101	S	MR	R	Oseco Inc.
Pinnacle	101	101	R	MR	HR	Hyland Seeds
526	103	100	S	S	HR	Pioneer Hi-Bred
532	103	101	S	S	HR	Pioneer Hi-Bred
5432	100	101	R	MR	HR	Pioneer Hi-Bred
Preserve	103	100	S	MR	R	Northrup King Seeds
Primal	102	100	S	S	HR	Pride Brand Seeds
Regal	101	94	S	MR	HR	United Cooperatives of Ontario
Saranac	100	100	S	S	R	Public
Shield	101	97	R	R	HR	Rothwell Seeds
Spectrum	101	98	S	MR	R	Labonte Seeds, Hyland Seeds
Sure	103	102	R	R	HR	Northrup King Seeds
Surpass	103	109	R	R	HR	Oseco Inc.
Thor	100	100	S	S	HR	Northrup King Seeds
Thunder	100	95	S	R	R	Oseco Inc.
Tomahawk	103	-	MR	MR	R	Speare Seeds
Trumpetor	98	98	MR	S	MR	Northrup King Seeds
Turbo	101	99	S	R	R	Pickseed
Ultra	103	-	R	R	R	Hyland Seeds
Valor	99	98	S	S	R	Rothwell Seeds
Verta +	104	102	R	R	HR	Speare Seeds
Vista	99	99	S	S	R	Pickseed, Mapleseed Inc.
WL 222	100	100	S	MR	R	King Agro, Speare Seeds
WL 316	101	96	R	MR	MR	King Agro, Speare Seeds

Average yield of Saranac in Southern Ontario trials 10.7 t/ha; in Northern Ontario trials 8.5 t/ha.

[1] *See Distributor Addresses in General Information section.*

[2] *HR = Highly Resistant (more than 50% resistant plants).*
R = Resistant (31 to 50% resistant plants).
MR =Moderately resistant (15 to 30% resistant plants).
S = Susceptible (less than 15% resistant plants).

Table 30. Recommended Bird's-foot Trefoil Varieties

Variety	Yield (% of Leo)		First Flower		Regrowth	Variable Drainage Tolerance	Distributor[1]
	S. Ontario	N. Ontario	(Guelph)	(Kapuskasing)			
Leo	100	100	June 23	June 30	Medium to Slow	Good	Public Variety
Upstart	102	97	June 23	June 30	Medium to Slow	Good	Pickseed
Empire	98	97	July 1	July 7	Slow	Excellent	Public Variety

[1] See Distributor Addresses in General Information section.
Average yield of Leo in Southern Ontario trials 8.5 t/ha; in Northern Ontario trials 5.7 t/ha.

Table 31. Recommended Double-Cut Red Clover Varieties

Variety	Yield (as % of Florex)				First Flower		Distributor[1]
	Southern Ontario		Northern Ontario				
	Year 1	Year 2	Year 1	Year 2	(Guelph)	(Kapuskasing)	
Arlington	99	92	92	91	June 15	June 29	Public Variety
Atlas	103	97	100	-	June 16	June 30	Northrup King Seeds
Florex	100	100	100	100	June 18	July 2	Northrup King Seeds Mapleseed Inc.
Prosper 1	101	94	98	99	June 18	July 2	King Agro
Persist	102	98	107	-	June 19	July 3	Northrup King Seeds
Walter	104	-	102	-	June 17	July 1	Mapleseed Inc.

[1] See Distributor Addresses in General Information section.
Average yield of Florex, Southern Ontario trials 9.6 t/ha; in Northern Ontario trials 6.5 t/ha.

Table 32. Recommended White Clover Varieties

Variety	Yield (% of Sacramento)		Distributor[1]
	S. Ontario	N. Ontario	
California Ladino	105	103	Public Variety
Canopy	106	104	Most Distributors
Merit	107	-	Public Variety
Sacramento	100	100	Tib Szego Associates Ltd.

[1] See Distributor Addresses in General Information section.
Average yield of Sacramento, Southern Ontario trials 6.2 t/ha; in Northern Ontario trials 4.5 t/ha.

Table 33. Recommended Timothy Varieties

Variety	Yield (% of Climax)		Heading Date		Regrowth	Distributor[1]
	S. Ontario	N. Ontario	(Guelph)	(Kapuskasing)		
Salvo	92	98	June 16	June 22	Good	SeCan Member
Toro	91	100	June 20	July 3	Good	Oseco Inc.
Basho	95	104	June 22	July 2	Good	Public
Richmond	99	101	June 22	July 2	Fair	Mapleseed Inc., Pickseed

(continued on page 6)

Table 33. Recommended Timothy Varieties (cont.)

Variety	Yield (% of Climax) S. Ontario	Yield (% of Climax) N. Ontario	Heading Date (Guelph)	Heading Date (Kapuskasing)	Regrowth	Distributor[1]
Champ	99	108	June 23	July 1	Good	Public
Mariposa	101	98	June 24	July 2	Good	United Co-operatives of Ontario
Nike	101	101	June 24	July 1	Fair	Pickseed
Itasca	101	101	June 25	July 3	Fair	United Co-operatives of Ontario
Alexander	100	99	June 26	July 4	Fair	Speare Seeds
Argus	104	104	June 26	July 4	Fair	Oseco Inc.
Timfor	100	102	June 26	July 3	Fair	Northrup King Seeds
Climax	100	100	June 28	July 5	Fair	Public
Glenmor	100	-	June 28	July 3	Good	Northrup King Seeds
Winmor	102	96	June 29	July 6	Fair	Northrup King Seeds

[1] *See Distributor Addresses in General Information section.*
Average yield of Climax, Southern Ontario trials 10.3 t/ha; in Northern Ontario trials 7.9 t/ha.

Table 34. Recommended Bromegrass Varieties

Variety	Yield (% of Baylor) S. Ontario	Yield (% of Baylor) N. Ontario	Heading Date (Guelph)	Heading Date (Kapuskasing)	Distributor[1]
Baylor	100	100	June 10	June 26	Oseco Inc.
Beacon	98	103	June 10	June 25	Oseco Inc., United Co-operatives of Ontario
Bravo	97	103	June 10	June 25	Pickseed
Saratoga	95	100	June 10	June 24	Public
Tempo	93	100	June 10	June 24	Pickseed, Mapleseed Inc.

[1] *See Distributor Addresses in General Information section.*
Average yield of Baylor, Southern Ontario trials 10.4 t /ha; in Northern Ontario trials 7.5 t /ha.

Table 35. Recommended Orchardgrass Varieties

Variety	Yield (% of Hallmark) S. Ontario	Yield (% of Hallmark) N. Ontario	Heading Date (Guelph)	Heading Date (Kapuskasing)	Distributor[1]
Hallmark	100	100	June 2	June 15	United Co-operatives of Ontario
Juno	99	103	June 2	June 15	Mapleseed Inc., Pickseed
Rapido	101	100	June 4	June 16	Pickseed
Napier	101	102	June 8	June 16	Oseco Inc.
Rancho	97	107	June 10	June 16	United Co-operatives of Ontario
Sumas	103	104	June 12	June 18	Oseco Inc.
Kay	101	109	June 12	June 18	Oseco Inc.

[1] *See Distributor Addresses in General Information section.*
Average yield of Hallmark, Southern Ontario trials 9.5 t/ha; in Northern Ontario trials 6.2 t/ha.

Table 36. Recommended Reed Canarygrass Varieties

Variety	Yield (% of Vantage) S. Ontario	Yield (% of Vantage) N. Ontario	Heading Date (Guelph)	Heading Date (Kapuskasing)	Distributor[1]
Vantage	100	100	June 10	June 24	Pickseed, Mapleseed Inc.
Venture	102	90	June 11	June 24	Speare Seeds
Palaton	99	94	June 11	June 25	Oseco Inc.

[1] *See Distributor Addresses in General Information section.*
Average yield of Vantage, *Southern Ontario trials 11.8 t/ha; in Northern Ontario trials 8.5 t/ha.*

Table 37. Recommended Meadow Foxtail Varieties

Variety	Yield (% of Mountain) S. Ontario	Yield (% of Mountain) N. Ontario	Heading Date (Guelph)	Heading Date (Kapuskasing)	Distributor[1]
Dan	98	100	May 15	May 30	Oseco Inc.
Mountain	100	100	May 12	May 27	Pickseed

[1] *See Distributor Addresses in General Information Section.*

Average yield of Mountain *Southern Ontario trials 9.2 t/ha; in Northern Ontario trials 5.3 t/ha.*

PESTICIDES FOR INSECT CONTROL IN FORAGE CROPS

Table 46. Alfalfa Weevil Control

Insecticide	Product per ha	Days to Cutting or Grazing
*Furadan 480F	285 mL	7
Imidan 50 WP	2.2 kg	7
Malathion 500 EC[1]	2-2.75 L	7

EC (Emulsifiable Concentrate); F (Flowable);
WP (Wettable Powder)

**Minimum period before reentry into treated areas is 48 hours.*

[1] *Less effective below 20 °C.*

Follow precautions applying to honeybees.

Table 47. Leafhopper Control

Insecticide[1]	Product per ha	Days to Harvest
Cygon 480 E	425 mL	2
*Guthion 240 SC	2.25-3.5 L	21

E (Emulsifiable Concentrate); SC (Sprayable Concentrate).

**Minimum period before reentry into treated areas is 48 hours.*

[1] *Follow precautions applying to honeybees.*

Table 48. Grasshopper Control

Insecticide	Product per ha	Days to Harvest
Basudin 50 W	1.1 kg	14
Malathion 500 EC[1]	2-2.75 L	7
*Guthion 240 SC	1.4 L	21

EC (Emulsifiable Concentrate); SC (Sprayable Concentrate);

**Minimum period before reentry into treated areas is 48 hours.*

[1] *Less effective below 20 ° C.*

Follow precautions applying to honeybees.

CEREAL CROPS

Table 50. Recommended Barley Varieties

Variety	Area Recommended	Type	Kernel weight (g/1000 seeds)	Height[1] (cm)	Lodging[2]	Maturity[3]	Diseases[4]				
							Leaf Rust	Loose Smut	Scald	Spot Blotch	Mildew
2-Rowed											
Albany	All	Rough-awned	43	70	2	92	5	3	8	8	1
Birka[5]	All except V & VI	Rough-awned	42	71	2	93	3	3	5	8	0
Craig	All	Rough-awned	40	70	3	91	5	3	5	8	0
Helena	All except V & VI	Rough-awned	43	70	2	91	5	3	8	8	1
Micmac	All except V & VI	Rough-awned	41	76	4	91	5	8	8	8	1
Rodeo	All	Rough-awned	42	75	2	92	5	3	8	8	0
6-Rowed											
Chapais	All	Rough-awned	43	72	2	91	7	5	5	8	2
Etienne	All	Smooth-awned	39	79	2	92	8	2	5	8	8
Joly	All except I	Smooth-awned	37	81	4	90	8	5	5	8	2
Leger	All	Smooth-awned	37	86	3	91	8	1	5	8	7
Maskot	All	Rough-awned	39	83	2	92	8	2	5	8	2
Mingo[5]	All except IV, VI	Smooth-awned	39	86	4	91	8	5	5	8	8
OAC Kippen	All	Rough-awned	38	84	3	91	5	6	5	5	0
Sabina	All	Rough-awned	40	82	2	92	7	2	5	8	1

[1] *In general, plants will be taller in the south and shorter in the north.*

[2] *Scale of 0-9, where 0 = standing and 9 = flat.*

[3] *Days to harvest. Subtract 5 days for areas I-IV and add 10 days for area VI.*

[4] *See Disease and Insect Control in Cereal Crops. Scale of 0-9, where 0 = very resistant and 9 = very susceptible.*

[5] *May be removed from the recommended list in 1991.*

Table 51. Relative Barley Yields[1, 2]

Variety	Test Areas					
	I	II	III	IV	V	VI
	%					
2-Rowed						
Albany	106	103	104	109	94	98
Birka	97	101	95	109	94	81
Craig	92	102	98	106	101	97
Helena	104	98	102	103	92	91
Micmac	98	99	99	108	100	98
Rodeo	107	100	98	107	97	100
6-Rowed						
Chapais	103	103	97	105	101	103
Etienne	100	101	89	90	101	104
Joly	104	92	104	86	103	111
Leger	101	103	111	97	101	112
Maskot	96	98	100	93	99	108
Mingo	10[illegible]	96	100	87	99	102
OAC Kippen	93	102	99	102	103	92
Sabina	100	101	105	97	117	105
Average yield[3] (t/ha)	3.7	3.7	4.0	3.9	4.4	5.2

[1] *Expressed as a percentage of the average yield of listed varieties in each area.*

[2] *Two year average (1988-89).*

[3] *1 t/ha = 893 lb/ac.*

Table 53. Relative Oat Yields[1, 2]

Variety	Test Areas					
	I	II	III	IV	V	VI
	%					
Baldwin	84	104	107	103	110	111
Donald	111	96	94	88	82	95
Dumont	76	88	94	93	87	93
Marion	123	106	106	108	122	104
Newman	116	104	102	113	98	105
OAC Woodstock	72	94	96	103	102	99
Ogle	123	113	103	101	97	95
Oxford	95	97	97	93	102	98
Average yield[3] (t/ha)	3.1	3.1	3.8	3.6	4.2	4.3

[1] *Expressed as a percentage of the average yield of listed varieties in each area.*

[2] *Two year average (1988-89).*

[3] *1 t/ha = 893 lb/ac.*

Table 52. Recommended Oat Varieties

Variety	Area Recommended	Type	Kernel weight (g/1000 seeds)	Height[1] (cm)	Lodging[2]	Maturity[3]	Diseases[4]			
							Leaf Rust	Barley Yellow Dwarf	Septoria	Smut
Baldwin[5]	All	white	33	102	4	96	8	8	8	5
Donald	All	white	34	92	3	95	8	5	8	1
Dumont[5]	III, V, VI	white	32	91	5	98	1	8	8	1
Marion	All	white	36	98	3	95	8	8	8	5
Newman	All	white	37	91	3	95	1	5	8	1
OAC Woodstock[5]	All	white	32	96	3	97	7	8	5	1
Ogle	All	yellow	31	82	1	93	5	3	3	5
Oxford[5]	All	yellow	30	92	2	98	5	5	3	1

Values are given to indicate relative differences between varieties; actual values will differ depending on growing conditions and disease pressures.

[1] *In general, plants will be taller in the south and shorter in the north.*

[2] *Scale of 0-9, where 0 = standing and 9 = flat.*

[3] *Days to harvest. Subtract 5 days for areas I-IV and add 10 days for area VI.*

[4] *See Disease and Insect Control in Cereal Crops. Scale of 0-9, where 0 = very resistant and 9 = very susceptible.*

[5] *May be removed from the recommended list in 1991.*

Table 54. Recommended Soft White Winter Wheat Varieties

Variety	Area Recommended	Kernel Weight	Awns	Height (cm)	Sprouting Resistance	Lodging[1]	Diseases Leaf Rust[2]	Scab[3]	Mildew[2]
Augusta	I, II, III	36	-	99	Medium	2.5	4.1	4.6	3.5
Ena	I	35	+	99	Medium	1.9	3.6	1.7	2.9
Frankenmuth[6]	I,[4] II[4]	35	-	98	Medium	2.7	4.4	3.9	2.8
Fredrick[6]	I[4]	37	-	104	Medium to good	2.0	3.1	2.5	3.0
Harus	I, II	37	-	94	Medium to good	1.7	4.4	2.4	2.6
Houser	III[5]	38	+	92	Poor	2.9	4.3	3.2	2.5

Winter survival is similar for all varieties.

All varieties should be seed treated to control loose smut.

Values are given to indicate relative differences between varieties; actual values will differ depending on growing conditions and disease pressure.

[1] *Scale of 0 - 9, where 0 = standing and 9 = flat.*

[2] *Scale of 0 - 9, where 0 = very resistant and 9 = very susceptible.*

[3] *Number of plants infected per 1000.*

[4] *Only where test weight is a problem with other varieties.*

[5] *Not on light, droughty soils and other locations where test weight is a problem.*

[6] *May be removed from the recommended list in 1991.*

Table 55. White Winter Wheat Relative Yields[1, 2]

Variety	Test Areas I	II	III
	....	%	....
Augusta	100	100	109
Ena	100	95	91
Frankenmuth	98	100	100
Fredrick	95	95	98
Harus	105	102	98
Houser	98	100	106
Average Yield[3] (t/ha)	4.3	4.4	4.7

[1] *Expressed as a percentage of the average yield of listed varieties in each area.*

[2] *Four year average (1986-1989).*

[3] *1 t/ha = 893 lb/ac.*

Table 56. White Winter Wheat Relative Test Weights[1, 2]

	Test Areas		
Variety	I	II	III
	%		
Augusta	97	98	98
Ena	100	102	101
Frankenmuth	101	101	101
Fredrick	103	101	102
Harus	102	101	100
Houser	97	97	97
Average test weight[3] (kg/hL)	73	74	80

[1] *Expressed as a percentage of the average test weight of listed varieties in each area.*

[2] *Four year average (1986-1989).*

[3] *kg/hL x .801 = lb/bu.*

New Table. Recommended Hard Red Winter Wheat Varieties

						Diseases	
Variety	Area Recommended	Kernel Weight	Height (cm)	Sprouting Resistance	Lodging[1]	Leaf Rust[2]	Mildew[2]
Absolvent	I, II, III	41	87	Very good	2.7	2.4	4.3
Karat	I, II, III	39	99	Very good	1.6	3.1	1.6

Winter survival is similar for all varieties.

All varieties should be seed treated to control loose smut.

Values are given to indicate relative differences between varieties; actual values will differ depending on growing conditions and disease pressure.

[1] *Scale of 0 - 9, where 0 = standing and 9 = flat.*

[2] *Scale of 0 - 9, where 0 = very resistant and 9 = very susceptible.*

New Table. Hard Red Winter Wheat Relative Yields[1, 2]

Variety	Test Areas		
	I	II	III
Absolvent	98	101	95
Karat	102	99	105
Average Yield[3] (t/ha)	3.7	3.7	4.2

[1] *Expressed as a percentage of the average yield of listed varieties in each area.*

[2] *Four year average (1986-1989).*

[3] *1 t/ha = 893 lb/ac.*

New Table. Hard Red Winter Wheat Relative Test Weights[1, 2]

Variety	Test Areas		
	I	II	III
Absolvent	101	101	100
Karat	99	99	100
Average test weight[3] (kg/hL)	74.5	75.7	83.3

[1] *Expressed as a percentage of the average test weights of listed varieties in each area.*

[2] *Four year average (1986-1989).*

[3] *kg/hL x .801 = lb/bu.*

Table 57. Distributors for Cereal Grain Varieties

	Variety	Distributor[1]	Breeder
Barley	Albany	SeCan Members	Charlottetown Res. Station
	Birka	W.G. Thompson & Sons Ltd.	Weibull's, Sweden
	Chapais	SeCan Members	Ste. Foy Research Station
	Craig	W.G. Thompson & Sons Ltd.	W.G. Thompson & Sons Ltd.
	Etienne	W.G. Thompson & Sons Ltd.	W.G. Thompson & Sons Ltd.
	Helena	King Agro	Dr. J. Ackerman, Germany
	Joly	King Agro	Semico, St. Hyacinthe
	Leger	SeCan Members	Plant Res. Centre, Ottawa
	Maskot	W.G. Thompson & Sons Ltd.	Semico, St. Hyacinthe
	Micmac	SeCan Members	Charlottetown Res. Station
	Mingo	W.G. Thompson & Sons Ltd.	Ciba-Geigy, Ailsa Craig
	OAC Kippen	SeCan Members	OAC, Guelph
	Rodeo	W.G. Thompson & Sons Ltd.	Ciba-Geigy, Ailsa Craig
	Sabina	King Agro	Semico, St. Hyacinthe
Oats	Baldwin	SeCan Members	Macdonald College
	Donald	SeCan Members	Plant Res. Centre, Ottawa
	Dumont	SeCan Members	Winnipeg Res. Station
	Marion	SeCan Members	Ste. Foy Research Station
	Newman	SeCan Members	Plant Res. Centre, Ottawa
	OAC Woodstock	SeCan Members	OAC, Guelph
	Ogle	Public	U. of Illinois
	Oxford	W.G. Thompson & Sons Ltd.	OAC, Guelph
	Tibor	W.G. Thompson & Sons Ltd.	Plant Res. Centre, Ottawa
Spring Triticale	OAC Triwell	King Agro	OAC, Guelph
Spring Wheat Feed			
Feed	Glenlea	Public	Univ. of Manitoba
Milling	Columbus	SeCan Members	Winnipeg Res. Station
	Katepwa	SeCan Members	Winnipeg Res. Station
	Max	C & M Seeds, Aishling Farm Seeds	Dr. Hegge, Germany
	Roblin	SeCan Members	Winnipeg Res. Station

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Table 57. Distributors for Cereal Grain Varieties (cont.)

	Variety	Distributor[1]	Breeder
Winter Barley	OAC Acton	King Agro	OAC, Guelph
	OAC Elmira	W.G. Thompson & Sons Ltd.	OAC, Guelph
	OAC Halton	SeCan Members	OAC, Guelph
Winter Triticale	OAC Decade	King Agro	OAC, Guelph
	OAC Trillium	SeCan Members	OAC, Guelph
	OAC Wintri	King Agro	OAC, Guelph
Winter Wheat			
Soft White	Augusta	W.G. Thompson & Sons Ltd.	Michigan State Univ.
	Ena	SeCan Members	Harrow Res. Station
	Frankenmuth	King Agro	Michigan State Univ.
	Fredrick	Public	Plant Res. Centre, Ottawa
	Harus	SeCan Members	Harrow Res. Station
	Houser	W.G. Thompson & Sons Ltd.	Cornell Univ.
Hard Red	Absolvent	C & M Seeds, Aishling Farm Seeds	Dr. P. Franck, Germany
	Karat	C & M Seeds, Aishling Farm Seeds	Probsdorfer, Austria

[1] See Distributor Addresses in General Information section.

PESTICIDES FOR INSECT CONTROL IN CEREALS

Table 65. Armyworm Control

Insecticide	Product per ha	Days to Harvest
Dylox 420 LC	1.5 L	21
*Lannate L 215	2.0 L	20
Sevin XLR PLUS 480 Su[1]	2.5-5.25 L	14

LC (Liquid Concentrate); L (Liquid); Su (Suspension) .

**Minimum period before reentry is 24 hours.*

[1] Registered on wheat and oats. Several formulations of Sevin are available for use according to label instructions. Sevin XLR PLUS is recommended because it is less hazardous to bees. Follow precautions applying to honeybees.

Table 66. Cereal Leaf Beetle Control

Insecticide	Product per ha	Days to Harvest
Malathion 500 EC[1]	.55 - 1.1 L	7
*Guthion 240 SC	1.75-2.25 L	30

EC (Emulsifiable Concentrate); SC (Sprayable Concentrate).

**Minimum period before reentry into treated areas is 48 hours.*

[1] Less effective below 20°C.

FIELD BEANS

Table 67. Field Bean Variety Recommendations

					Disease Reaction[2]	
Variety	Heat Unit Rating	Yield[1] (t/ha)	Days to Maturity	100 seed Weight (g)	Bean Common Mosaic Virus (%)	Anthracnose Delta Race
			White Beans			
OAC Seaforth	2550	2.3	93	21	R	R
Mitchell	2550	2.4	94	20	R	S
Centralia	2650	2.6	94	22	R	R
Midland	2650	2.6	96	18	R	S
Rocket	2700	2.5	98	22	R	S
Wesland	2700	2.6	99	22	R	S
Stinger	2750	2.7	100	21	R	S
Dresden	2750	2.6	103	20	R	R
Fleetside	2800	2.7	103	20	R	R
OAC Rico	2800	2.7	103	20	R	R
Ex Rico 23	2800	2.7	104	21	R	S
Crestwood	2800	2.7	104	22	R	R
			Yellow Eyes			
Aresteuben	2850	1.8	101	43	S	R

[1] *Three year average except for Aresteuben (1 year).*

[2] *Also see Disease and Insect Recommendations (R-Resistant, S-Susceptible).*

Table 68. Distributors for Field Bean Varieties

Variety	Distributor[1]
OAC Seaforth	Public variety
Mitchell	Public variety
Centralia	Public variety
Midland	W.G. Thompson and Sons Ltd.
Rocket	W.G. Thompson and Sons Ltd.
Wesland	W.G. Thompson and Sons Ltd.
Stinger	W.G. Thompson and Sons Ltd.
Dresden	Public variety
Fleetside	Cooks, W.G. Thompson and Sons Ltd.
OAC Rico	Public variety
Ex Rico 23	Public variety
Crestwood	Cooks, W.G. Thompson and Sons Ltd.
Aresteuben	Public variety

[1] *See Distributor Addresses in General Information section.*

PESTICIDES FOR INSECT & DISEASE CONTROL IN FIELD BEANS

Table 73. White Mold Control

Fungicide	Product per ha
Benlate 50 W	1.7-2.25 kg
Rovral 50 W	1.0-1.5 kg
Easout 70 W	1.75-2.25 kg
Botran 75 W	3.25 kg

W (Wettable Powder).

Do NOT feed treated bean refuse to livestock.

Table 74. Cloverworm Control

Insecticide[1]	Product per ha	Days to Harvest
Thiodan 4 EC	1.5-2.0 L	2
*Guthion 240 SC	1.75-2.25 L	3

EC (Emulsifiable Concentrate); SC (Sprayable Concentrate).

**Minimum period before reentry into treated areas is 48 hours.*

[1] Follow precautions applying to honeybees.

Table 75. Mexican Bean Beetle and Leafhopper Controls

Insecticide[1]	Product per ha	Days to Harvest	Comments
Cygon 480 E	0.7-1.0 L	7	Do not use straw for feed or bedding.
Thiodan 4 EC	1.5-2.0 L	2	
*Guthion 240 SC	2.25 L	3	

E or EC (Emulsifiable Concentrate); SC (Sprayable Concentrate).

**Minimum period before reentry into treated area is 48 hours.*

[1] Follow precautions applying to honeybees.

Products may be applied as a band over the row.

Table 76. Grasshopper Control

Table 76 has been deleted in its entirety, as none of the insecticides listed are currently registered for grasshopper control in field beans.

SPRING CANOLA

Table 77. Recommended Spring Canola Varieties

Variety	Days from Planting to Maturity	Yield[1,2] (t/ha)	Lodging 1 = standing 5 = flat	Distributor[3]
Westar	93	2.1	2.2	SeCan Members
Legend	95	2.1	2.1	Bonis & Co. Ltd.
Vanguard	95	2.2	2.1	Bonis & Co. Ltd.
Celebra	97	2.2	1.8	Bonis & Co. Ltd.
W1471	97	2.4	1.6	W.G. Thompson & Sons Ltd.
Delta	97	2.4	2.0	W.G. Thompson & Sons Ltd.
Topas	98	2.0	1.6	Bonis & Co. Ltd.
Global	100	2.2	1.5	Bonis & Co. Ltd.
Triazine-resistant				
OAC Triton	97	1.5	2.8	SeCan Members
OAC Triumph	98	1.5	1.9	SeCan Members
Stallion	98	1.7	2.0	Bonis & Co. Ltd.

[1] *1 t/ha = 893 lb/acre = 17.86 bu/ac.*

[2] *Values shown are averages of 15 trials over 3 years.*

[3] *See Distributor Addresses in General Information section.*

WINTER RAPESEED

Table 83. Recommended Winter Rapeseed Varieties

Variety	Maturity[3] Date (July)	Yield[1,3] (t/ha)	Winter[2] Survival (%)	Lodging[2] 1 = standing 5 = flat	Distributor[4]
Ceres	11	2.7	85	1.4	King Agro
Arabella	12	2.6	82	1.5	Agri Seed Ltd.
Tandem	13	2.6	86	1.4	King Agro
Crystal	13	2.2	83	1.6	Bonis & Co. Ltd.

[1] *1 t/ha = 893 lb/ac. = 17.86 bu/ac.*

[2] *Values shown for winter survival and lodging are averages of 10 trials over 3 years.*

[3] *Values shown for yield and maturity dates are averages of 11 and 8 trials, respectively, over 3 years.*

[4] *See Distributor Addresses in General Information Section.*

PESTICIDES FOR INSECT & DISEASE CONTROL IN CANOLA

Table 81. Flea Beetle Control

Insecticide	Product per ha	Days to harvest
Seed-furrow application:		
Counter 5G	5.5-11 kg	Planting time only
Furadan CR-10G	2.8 kg	
Postemergent spray:		
Cymbush 250 EC	140 mL	30
Ripcord 400 EC	50 mL	30
Decis 2.5 EC	200-300 mL	14
*Furadan 480 F	150-275 mL	60
*Guthion 50 WP	150-275 g	30
240 SC	275-550 mL	30
Sevin XLR PLUS 480 Su	500 mL	60

G (Granular); F (Flowable); WP (Wettable Powder); SC (Sprayable Concentrate); EC (Emulsifiable Concentrate); Su (Suspension); CR (Special formulation for Canola Rape).

**Minimum period before reentry into treated areas is 48 hours.*

Table 82. Diamondback Moth Control

Insecticide[1]	Product per ha	Days to Harvest
Dylox 80% SP	1.5 kg	21
420 L	2.75 L	21
*Guthion 50 WP	275-550 g	30
240 SC	.55-1.25 L	30

SP (Soluble Powder); L (Liquid); WP (Wettable Powder); SC (Sprayable Concentrate).

[1] *Use Dylox if canola is in bloom because it is less hazardous to bees.*

**Minimum period before reentry into treated areas is 48 hours.*

GENERAL INFORMATION ON PESTICIDES

Table 89. Pesticide Toxicity to Bees

Extremely Toxic

Sevin Furadan

These insecticides have caused more loss (confirmed cases of poisoning) to bees than any of the other materials listed below. Growers and apiarists require close liaison where these materials are used.

Table 89. Pesticide Toxicity to Bees (cont.)

Highly Toxic

Ambush
Cygon
Cymbush
Decis
diazinon
Guthion
Imidan
Lorsban
malathion
Ripcord

Severe losses may be expected if these materials are used when bees are present at treatment time or within a few days thereafter.

Moderately Toxic

Dylox
Lannate
Thiodan

These can be used around bees if dosages, timing, and methods of application are correct, but should not be applied directly on bees, in the field or at the colonies.

Relatively Non-Toxic

All the fungicides

Table 91. Fungicides

Trade Name & Formulation (active ingredient)	Fungicide Classification	Days to Harvest	Relative Toxicities	Aerial Application	Distributors	Use and Remarks	Ontario Schedule[1]
Bayleton 50WP (triadimefon)	triazole	60	Low	No	Van Waters & Rogers	hard red, soft white winter wheat	1
Benlate 50WP (benomyl)	benzimidazole	14	Low	Yes	Bartlett Niagara U.A.P. Van Waters & Rogers	field beans	3
Botran 75W (dichloran)	nitroaniline	2	Low	Yes	U.A.P.	field beans	3
Dithane M45 (mancozeb)	dithiocarbamate	40	Low	Yes	Barlett U.A.P.	spring and winter wheat	3
Easout, 70%WP (thiophanate-methyl)	benzimidazole	14	Low	Yes	Ciba-Geigy	field beans	3
Rovral, 50%WP (iprodione)	dicarboximide	14	Low	Yes	Bartlett Niagara UCO	field beans	3
Tilt 250E (propiconazole)	triazole	45	Low	No	Ciba-Geigy	wheat and spring barley	5

W or WP (Wettable Powder); E(Emulsifiable Concentrate).

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[1] *The numbers identify the Schedules in which the* TRADE NAME *products listed in this Table are classified under the Pesticide Act. See Table 92 for explanation of schedules.*

Table 92. Explanation of Schedules, Provincial Classification of Pesticides

Ontario Schedule	Explanation of Schedule
Schedule 1	Restricted. Use permit only.
Schedule 2	Restricted to agriculturalists, licenced exterminators and registered custom sprayers.
Schedule 3	May be available for "Domestic" purposes if so registered.
Schedule 4	"Domestic" products only.
Schedule 5	Limited to application by an agriculturist.
Schedule 6	Similar to schedule 4 but may be registered for agricultural/ commercial use.

For further information on the regulatory aspects of the classification, please contact the Ministry of the Environment office nearest you.

Table 93. Insecticides

Trade Name & Formulation (active ingredient)	Insecticide Classification	Days to Harvest	Relative Toxicities	Aerial Application	Distributors	Use and Remarks	Ontario Schedule[1]
Ambush 500 EC (permethrin)	pyrethroid	Not after 5-leaf stage	Moderate	No	ICI Chipman UCO	Corn	(3)
Bactospiene (*bacillus thuringiensis)*	Bacterial toxin	0	Low	Yes	Bartlett Niagara U.A.P.	Seed Corn	(3)
Basudin 50 W (diazinon)	organo-phosphorus	14	Moderate	Yes	Ciba-Geigy	Alfalfa, corn, field beans, peas. Toxic to bees.	(2)
Counter 15 G, 5G (terbufos)	organo-phosphorus	planting time only	Extreme	No	Cyanamid	Corn, Canola	(5)
Cygard 15-G (terbufos + phorate)	organo-phosphorus	planting time only	Extreme	No	Cyanamid	Corn	(5)
Cygon 480 E (dimethoate)	organo-phosphorus	2 Alfalfa 7 Beans	Moderate	Yes	Bartlett ICI Chipman Niagara Cyanamid UCO	Alfalfa, field beans. Toxic to bees.	(2)
Cymbush 250 EC (cypermethrin)	pyrethroid	30 Canola 5 Corn	Moderate	No	ICI Chipman UCO	Corn, Canola	(2)
Decis 2.5 EC (deltamethrin)	pyrethroid	14	Moderate	No	Niagara	Canola	(2)
Dipel SC (*Bacillus thuringiensis*)	Bacterial toxin	0	Low	Yes	Niagara	Timothy	(3)
Di-Syston 15 G, 720 LC (disulfoton)	organo-phosphorus	planting time only	Extreme	No	Niagara U.A.P. Van Waters & Rogers	Corn	(5)

Table 93. Insecticides (cont.)

Trade Name & Formulation (active ingredient)	Insecticide Classification	Days to Harvest	Relative Toxicities	Aerial Application	Distributors	Use and Remarks	Ontario Schedule[1]
Dyfonate 20 G (fonofos)	organo-phosphorus	planting time only	Extreme	No	ICI Chipman UCO, U.A.P, Cargill	Corn	(5)
Dylox 80% SP, 420 Liquid (trichlorfon)	organo-phosphorus	21	Low	Yes	Niagara	Canola, cereals. Relatively safe to bees.	(3)
Furadan 10 G, CR-10 G, 480 F (carbofuran)	carbamate	planting time only 7	Extreme	Yes Permit Required	Bartlett Niagara UCO U.A.P. Van Waters & Rogers	Corn, Canola, Alfalfa. Toxic to bees.	(2) (Granular) (5) (Flowable)
Guthion 240 SC (azinphos-methyl)	organo-phosphorus	3 Beans 21 Alfalfa 30 Grain	Extreme	Yes Permit Required	Bartlett Niagara U.A.P.	Field beans, soybeans. Toxic to bees.	(5)
Imidan 50 WP (phosmet)	organo-phosphorus	7	Moderate	Yes	Bartlett ICI Chipman	Alfalfa. Toxic to bees.	(3)
Lannate L. (methomyl)	carbamate	21	Extreme	Yes	Niagara U.A.P. Van Waters & Rogers	Grain	(2)
Lorsban 4 E, 15 G (chlorpyrifos)	organo-phosphorus	70	Moderate	Yes Permit Required	U.A.P.	Corn	(2),(3)
Malathion 500 EC, 25 W (malathion)	organo-phosphorus	7	Low	Yes	Bartlett Niagara U.A.P. UCO	Alfalfa, grain crops, field beans soybeans. Toxic to bees. Less effective below 16°C	(3)
Ripcord 400 EC (cypermethrin)	pyrethroid	30	Moderate	No	Ciba-Geigy	Canola Corn	(2)
Sevin XLR PLUS 480 Su (carbaryl)	carbamate	5 Beans 2 Alfalfa 14 Cereals	Moderate	Yes	Niagara UCO	Alfalfa, cereals beans, corn canola	(3)
Thimet 15 G (phorate)	organo-phosphorus	planting time only	Extreme	No	Cyanamid	Corn	(2)
Thiodan 4 EC (endosulfan)	organo chlorine	2	Moderate	Yes	Niagara U.A.P., UCO	Field beans, soybeans. Toxic to bees.	(2)

(continued on page 22)

Table 93. Insecticides (Cont.)

Trade Name & Formulation (active ingredient)	Insecticide Classification	Days to Harvest	Relative Toxicities	Aerial Application	Distributors	Use and Remarks	Ontario Schedule[1]
Thuricide HPC (*Bacillus thuringiensis*)	Bacterial toxin	0	Low	Yes	Sandoz	Timothy	(3)

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[1] The numbers identify the Schedules in which the TRADE NAME products listed in this Table are classified under the Pesticides Act. See Table 92 for explanation of schedules.

Table 94. Distributors of Pesticides Recommended in Publication 296

Bartlett Inc.
931 Bartlett Road
Beamsville, Ont. L0R 1B0 416-563-8261

ICI Chipman
400 Jones Road, P.O. Box 9910
Stoney Creek, Ont. L8G 3Z1 416-643-4123

Ciba-Geigy Can. Ltd.
Agricultural Division
6860 Century Avenue
Mississauga, Ont. L5N 2W5 519-623-7600

Cyanamid Canada Inc.
88 McNabb St.
Markham, Ont. L3R 6E6 416-470-3600

Niagara, Business Unit of
Rhone-Poulenc Canada Inc.
555 Southgate Dr.
Guelph, Ont. N1H 6J3 519-767-1000

Sandoz Agro Canada Inc.
Suite 302, Plaza 4
2000 Argentina Rd.
Mississauga, Ont. L5N 1W1 416-821-7850

United Agri Products (U.A.P.)
1 Wilton Grove Rd.
P.O. Box 22116
London, Ont. N6C 4N0 519-681-2173

United Cooperatives of Ontario
P.O. Box 527, Station A
Mississauga, Ont. L5A 3A4 416-270-3560

Van Waters & Rogers
1020 Hargrieve Road, Unit D
London, Ont. N6E 1P5 519-668-3007

DISTRIBUTORS OF VARIETIES RECOMMENDED IN PUBLICATION 296

Agri Seed Ltd. Box 1415, Chatham, Ontario N7M 5W8	519-354-7251
Aishling Farm Seeds R.R.#2, Baltimore, Ontario K0K 1C0	416-372-5359
Allelix Inc. 6850 Goreway Drive, Mississauga, Ontario L4V 1P1	416-677-0831
Bishop Farm Seeds Limited Box 338, Belleville, Ontario K8N 5A5	613-968-5533
Bonis & Co. Ltd. P.O. Box 217, Lindsay, Ontario K9V 5Z4	705-324-0544
C & M Seeds R.R. #3, Palmerston, Ontario N0G 2P0	519-343-2126
Cargill Hybrid Seeds Box 490, Princeton, Ontario N0J 1V0	519-458-4336
Dekalb Canada Inc. Box 430, Chatham, Ontario N7M 5K5	519-352-5310
First Line Seeds R.R. #2, Guelph, Ontario N1H 6H8	519-821-0882
Funk Seeds Ciba-Geigy Canada Limited R.R. #3, Cottam, Ontario N0R 1B0	519-839-4851
Jacques Canada Limited P.O. Box 598, Niagara Falls, Ontario L2E 6V2	1-800-843-5362
King Agro P.O. Box 1088, Chatham, Ontario N7M 5L6	519-354-3210
Labonté Seeds Limited Box 1660, New Liskeard, Ontario P0J 1P0	705-647-6821
Mapleseed Inc. Oakwood, Ontario K0M 2M0	705-786-2020
Northrup Kings Seeds Limited 1250 Franklin Boulevard, Box 1207 Cambridge, Ontario N1R 6C9	519-621-0890
Oseco Inc. P.O. Box 219, Brampton, Ontario L6V 2L2	416-846-5080
Heritage Seeds 75 Cardigan Street, Guelph, Ont. N1H 3Z7	519-822-4800
Otto Pick & Sons Seeds Limited (Pickseed) Box 126, Richmond Hill, Ontario L4C 4X9	416-884-1147
Parsons Seeds Ltd. P.O. Box 280, Beeton, Ontario L0G 1A0	416-729-2202
Pioneer Hi-Bred Limited Box 730, Chatham, Ontario N7M 5L1	519-352-6350
Pride Brand Seeds P.O. Box 1088, Chatham, Ontario N7M 5L6	519-354-3210
Rothwell Seeds Limited Box 511, Lindsay, Ontario K9V 4L9	705-324-9591
SeCan Association* Suite 512, 885 Meadowlands Drive Ottawa, Ontario K2C 3N2	613-225-6891
Speare Seeds Limited P.O. Box 171, Harriston, Ontario N0G 1Z0	519-338-3840
Tib Szego Associates Limited P.O. Box 366, Lindsay, Ontario K9V 4S3	705-324-0042
United Cooperatives of Ontario 151 City Centre Drive Mississauga, Ontario L5A 3A4	416-270-3560
W.G. Thompson & Sons Limited Box 250, Blenheim, Ontario N0P 1A0	519-676-5411

**SeCan is an association of seed growers and seed companies which handles the release and promotion of publicly developed varieties. For more information on these varieties, contact your local SeCan member.*

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